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DEVELOPMENT OF A ROTOR WAKE/VORTEX MODEL

VOLUME II - USER'S MANUAL FOR COMPUTER PROGRAM

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1.0 INTRODUCTION

This volume and the sister volume (Reference 1) comprise the contractor reports on contract number NAS3-23681. Volume I describes the rotor wake and vortex model development and the results of the studies carried out using the model. This volume (Volume II) is subdivided into the following sections:

- Description and Flow Chart of the Computer Program
- Listing of the Computer Program
- Definition of Input/Output Parameters
- A sample Input/Output Case
- Input files for Rotor 55, JT15D Fan Rotor, and Rotor 67
- References

2.0 DESCRIPTION AND FLOW CHART OF THE COMPUTER PROGRAM

The computer program predicts the rotor wake/vortex flow distributions and the resultant stator upwash gust velocity field. The program is based on a meridional-plane stream surface subdivision of the rotor-stator stage flowpath annulus. The program is designed to use as input the rotor inlet and exit aerodynamic vector diagram parameters such as absolute and relative flow angles and Mach numbers, rotor blade section properties such as solidity and aerodynamic chord length, and aerodynamic properties such as section drag coefficient, work coefficient, etc., as a function of immersion.

The viscous wake model developed in Section 3.1 of Reference 1 is programmed to predict the wake mean flow velocity and turbulent velocity profile development along each meridional streamline at each preselected spanwise location in the fan stage flowpath. The program is designed to predict these profiles at preselected (user input) axial distances downstream of the rotor trailing edge. The vortex model developed in Section 3.2 of Reference 1 is programmed to predict the hub and tip secondary vortex mean flow velocity fields at each preselected axial station as a function of circumferential distance on each meridional streamline (radial distance). The wake and vortex mean velocity fields are superimposed linearly to calculate the resulting mean velocity circumferential profiles at the desired radial immersions and axial stations in a reference frame fixed to the rotor.

The computer program is designed to transform the rotor-fixed wake/vortex combined flow mean velocity profiles and wake-produced turbulence velocity profiles into a reference frame fixed to the stationary observer (stator coordinates) and resolve the various rotor-fixed velocity components into their components in a stator-fixed upwash direction. Fourier analysis of the upwash waveform is performed numerically using Simpson's Rule to evaluate the resulting stator upwash gust harmonic amplitude distribution. An analysis, developed under a GE IR&D program, for evaluating the spanwise distortion and clocking of the rotor wake "sheet" trajectory as it convects downstream is incorporated into the program to predict the spanwise aerodynamic phase lag of the wake/vortex velocity field. The aerodynamic phase lag is computed relative to the tip streamline. Thus, one obtains the spanwise distribution of the amplitude and relative phase of the gust upwash harmonic content. The program computes the turbulent velocity spectrum based on an axisymmetric turbulence model (see Subsection 3.3.2 of Reference 1) at the same location where the gust upwash harmonic content is computed. A flow chart of this computer program is given in Figures 1 through 5.

The user's attention is drawn to the following specific features incorporated into the computer program:

I. Three models of predicting the centerline defect and semiwake width:

   1. Linear rational function model (see subsection 3.1.1 of Reference 1)
   2. Kemp and Sears model (see Reference 2)
   3. Mugridge and Morfey model (see Reference 3)

II. Two wake shape functions:

1. Gaussian profile ($e^{-\ln 2 \eta^2}$)
2. Hyperbolic secant profile (sech ($a\eta$), $a = \cosh^{-1} 2$)

III. Three ways of prescribing the rotor section drag coefficient:

1. Prescribe a drag coefficient for each streamline
2. Compute the drag coefficient at each streamline from a measured value of profile loss coefficient
3. Compute the drag coefficient at each streamline from a profile loss coefficient which is correlated with the diffusion factor for several NACA 65-(A_{10})-series and double circular-arc blades (Reference 4)

IV. Axial, tangential, and radial turbulent velocities normalized by the free stream velocity are computed at the desired downstream location and a flat profile is prescribed for them in the tangential direction.

V. Both tip and hub vortices are incorporated in the program with options to include both of them, neither of them, or either one of them. Certain existing empirical relations have been used in estimating the strength and radius of the tip vortex. However, no such information is currently available for hub vortex model. When such relations for estimating the strength and radius of hub vortex become available, they can be incorporated into the computer program. The computer code also gives the trajectories of the centers of hub and tip vortices.

VI. The computer program in the default mode computes the gust harmonic spectrum and the turbulent velocity spectrum model at the 1/4 chord point of the stator. However, by setting ISTATR=0, the spectra can be computed at the leading edge of stator or at any station between the rotor trailing edge and the stator leading edge.

The computer program source code contains approximately 1000 lines. It consists of:

- Main program, which manipulates input, output and all the subroutines. It also computes the tip-to-hub aerodynamic phase lag, once all the streamline computations are performed.
- Subroutine DRAGQ, which computes the section drag coefficient.
- Subroutine WAKE1, which computes the wake centerline defect and semiwake width.

- Subroutine WAKE2, which computes the tangential wake profiles.
- Subroutine TURBVEL, which computes the turbulent velocities.
- Subroutine VORTX1, which computes the vortex strength and radius of tip and hub vortices.
- Subroutine VORTX2, which computes the velocity field induced by tip and hub vortices.
- Subroutine HRMONIC, which computes the harmonic content of rotor wake/vortex gust.
- Subroutine TUBSPCT, which computes the axisymmetric turbulence spectrum.

In the time share mode, on the Honeywell 6000 computer system, one case typically requires about 10 seconds of CPU time. Hence, this program is ideally suited for performing extensive parametric studies.

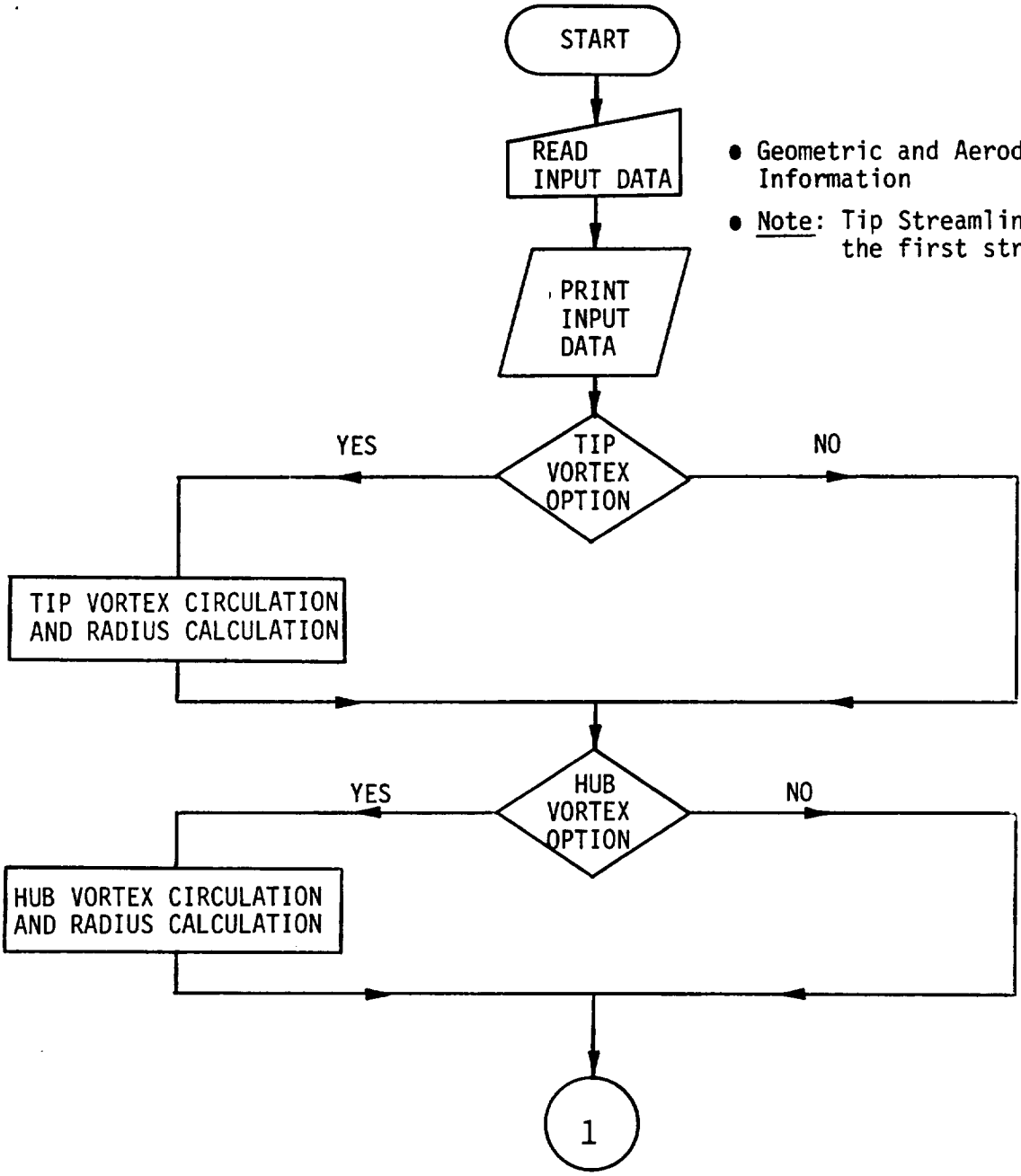

Figure 1. Program Flow Chart for Rotor Wake/Vortex Model.

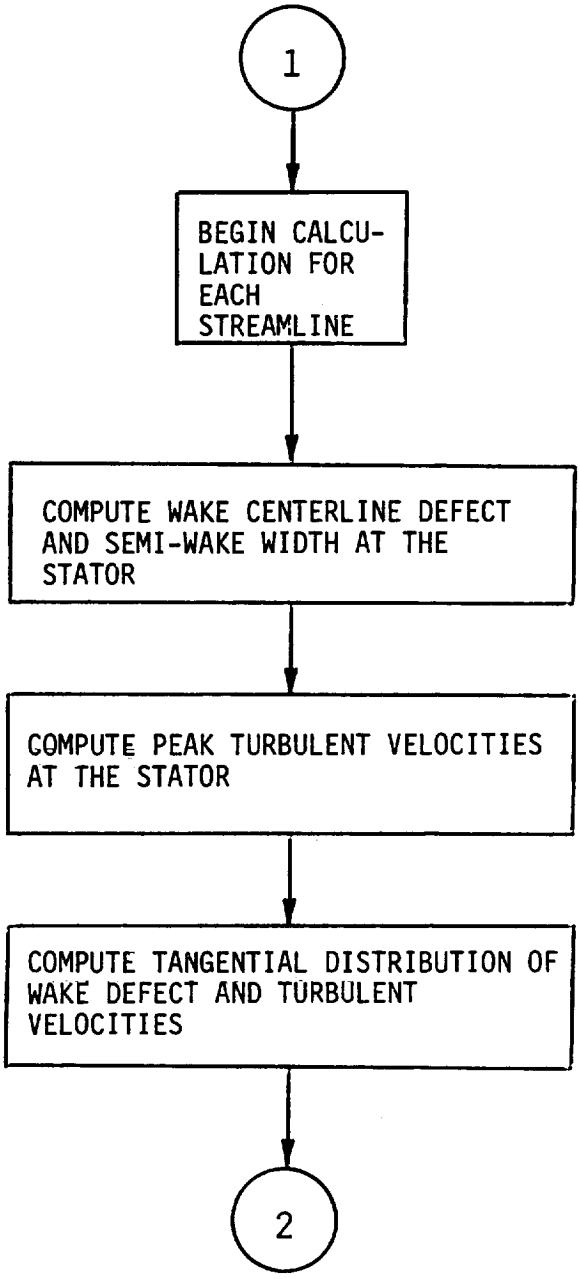

Figure 2. Program Flow Chart for Rotor Wake/Vortex Model (Continued).

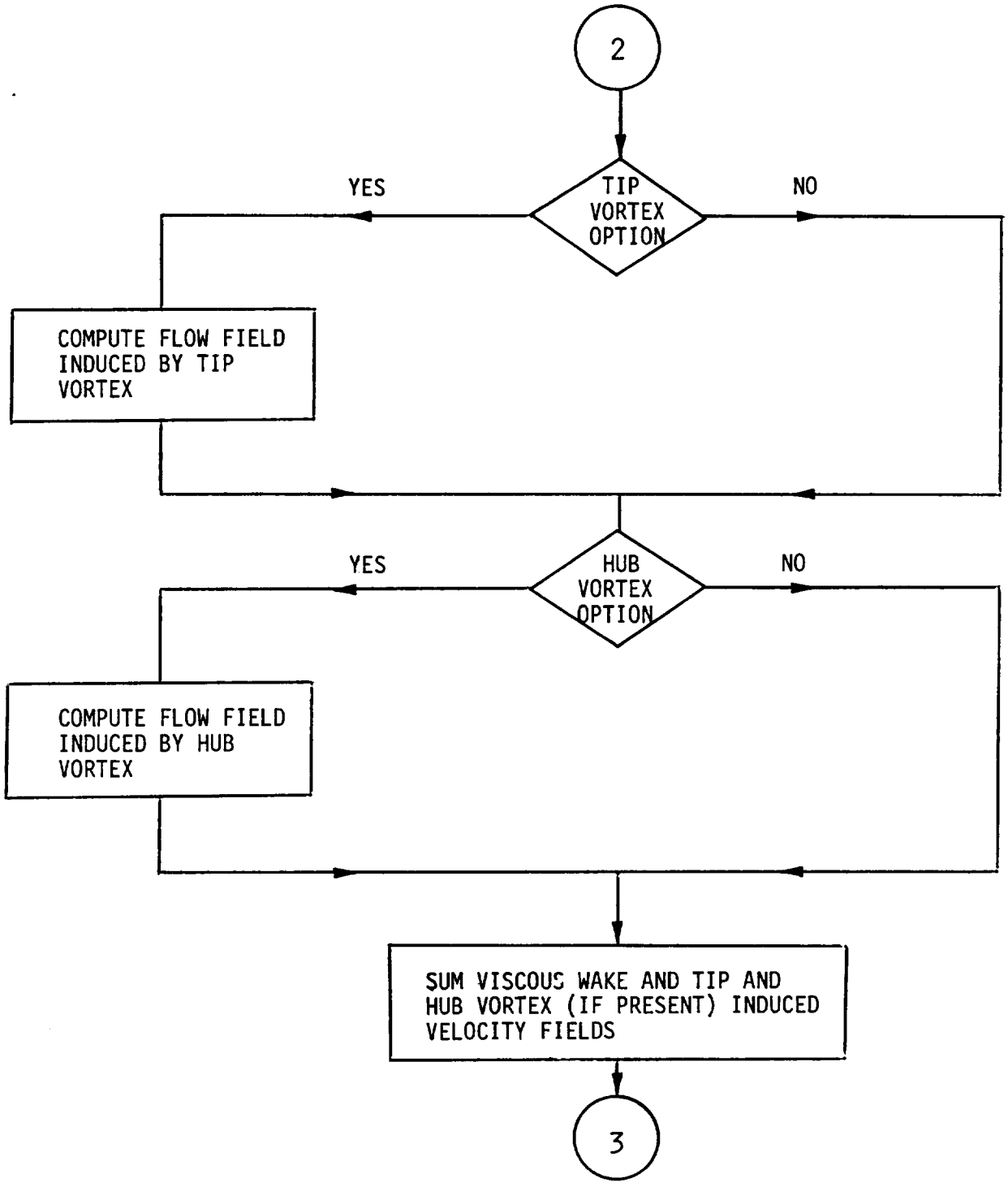

Figure 3. Program Flow Chart for Rotor Wake/Vortex Model (Continued).

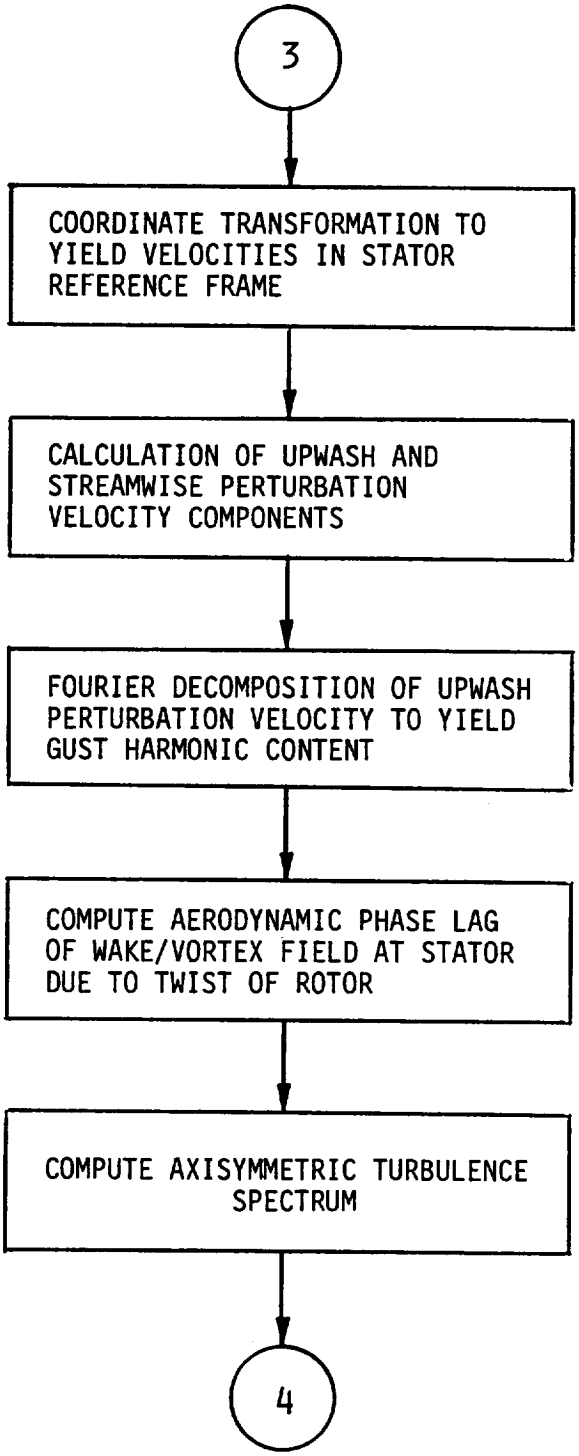

Figure 4. Program Flow Chart for Rotor Wake/Vortex Model (Continued).

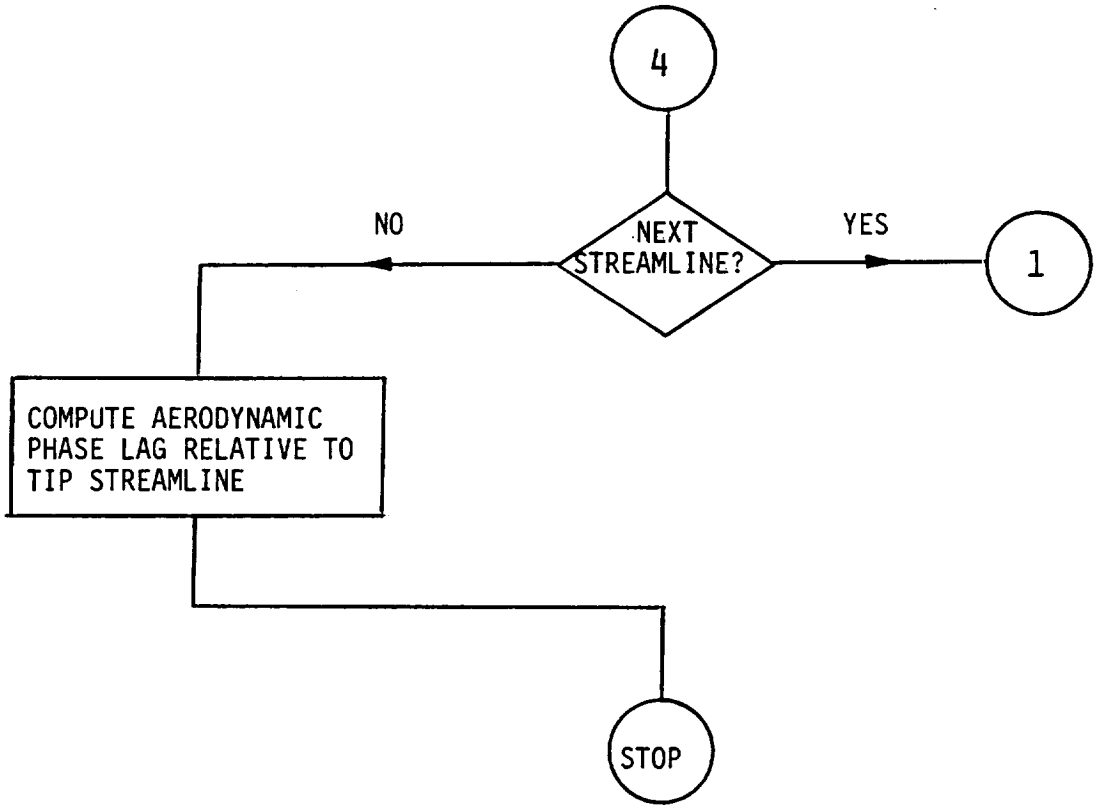

Figure 5. Program Flow Chart for Rotor Wake/Vortex Model (Concluded).

3.0 LISTING OF THE COMPUTER PROGRAM

A listing of the computer program in the Fortran language is enclosed in this section.

```
C      ROTOR EXIT FLOW GUST DESCRIPTION
C
       REAL *4 LINE
C
       DIMENSION LINE(20)
       DIMENSION THETA(300),BETA(300),WT(300),WS(300),WN(300),VT(300),
      & VN(300),VS(300),ALPHA(300),VTP(300),VPS(300),
      & WTO(300),WTIF(300),WSC(300),
      & WNC(300),NST(300),
      & RSTAGR(21),SSTAGR(21),SR(21),
      & SXOCH(21),SSIGS(21),PHI(21),PLAG(21),
      & UVTI(300),WTI(300),WTOT(300)
C
       COMMON /FANVTX/NSTR,SSIGR(21),SSEMA(21),SSTHET(21),SSEMT(21)
       COMMON /FAN/SEMA,SEMT,STHETA,SIGR,SADINS
       COMMON /DRAG/ ICD,CD,WR,SCD(21),SWR(21)
       COMMON /VTEX1/ ITPVTX,IHBVTX,TAU,ALPHR,CHORD,WTOO
       COMMON /VTEX2/ SAODS(2),SCIRCO(2),SOO(2),SVSDVO(2),SCL(2),
      & SFRL(2)
       COMMON /VTEX3/ SBN(2),SBR(2),SDIST,N,RAWDS,R,VINRVT(300,2),
      & VISRVT(300,2),HTR,VINRV(300),VISRV(300),NBLADE
       COMMON /HMONIC/ ST(300),VPN(300),FCA(30,21),FCB(30,21),FCDB(30,21)
       COMMON /TURB/NFREQ,DELFRQ,RELDBT(21,200)
C
       NAMELIST/INPUT/
      & AO,BETAW,DELFRQ,FOPT,HTR,ICD,IHBVTX,ISHAPE,ISTATR,
      & ITPVTX,ITURB,IWAKE,KASE,N,NBLADE,NFREQ,NHT,NSTR,
      & NVANE,RAWDS,RSTAGR,RWALL,SBN,SCD,SR,SSEMA,SSEMT,
      & SSIGR,SSIGS,SSTAGR,SSTHET,SWR,SXOCH,TAU,
      & VREF,VVTR,WOPT,WTIV
C
C INDEX FOR SELECTION OF WAKE MODELS:
C   IWAKE=1 LINEAR RATIONAL FUNCTION MODEL
C   IWAKE=2 SILVERSTEIN/KEMP & SEARS MODEL
C   IWAKE=3 MUGRIDGE & MORFEY MODEL
C INDEX FOR SELECTION OF WAKE SHAPES
C   ISHAPE=1 SECH(A*X),WHERE A IS A CONSTANT
C   ISHAPE=2 EXP(-LN2*X**2)
C INDEX FOR DRAG COEFFICIENT (CD) SELECTION
C   ICD=1 INPUT ONE VALUE OF CD FOR EACH STREAMLINE
C   ICD=2 COMPUTE CD FROM INPUT VALUE OF LOSS COEFFICIENT (WR)
C   ICD=3 COMPUTE CD FROM LOSS COEFFICIENT WHICH IS COMPUTED
C         FROM DIFFUSION FACTOR (SEE NASA SP 36,P.232,P.248,EQ.278. 19  65
C ITPVTX=1 TIP VORTEX COMPUTATIONS TO BE DONE (DEFAULT OPTION)
C       =0 NO TIP VORTEX COMPUTATIONS
C IHBVTX=1 HUB VORTEX COMPUTATIONS TO BE DONE
C       =0 NO HUB VORTEX COMPUTATIONS (DEFAULT OPTION)
C ITURB=1 TURBULENCE SPECTRUM COMPUTED (DEFAULT OPTION)
C      =0 TURBULENCE SPECTRUM NOT COMPUTED
C ISTATR=1 STATOR EXISTS (DEFAULT OPTION)
C       =0 ROTOR ALONE
C
       WRITE (06,1000)
  100  READ (10,1010,END=110) LINE
       WRITE (06,1010) LINE
       GO TO 100
```

```
  110 REWIND 10
C
      ICD=1
      IHBVTX=0
      IPRNT=1
      ISHAPE=1
      ISTATR=1
      ITPVTX=1
      ITURB=1
      IWAKE=1
      SBN(1)=0.5
      SBN(2)=0.0
C
      WRITE (06,1100)
C
      KASE=1
      NCASE=0
  200 NCASE=NCASE+1
      IF (IPRNT.LE.0) GO TO 210
      WRITE (06,1110) NCASE
  210 CONTINUE
C
C READ NAMELIST INPUT
C
      READ (10,INPUT,ERR=980,END=990)
C
C INITIALIZE CONSTANTS
C
      PI=4.*ATAN(1.)
      DTR=PI/180.
      RTD=1./DTR
C
      IF (ITPVTX.EQ.0.AND.IHBVTX.EQ.0) GO TO 300
      CALL VORTX1
      GO TO 310
  300 WRITE (06,1120)
C
C INDEX OVER STREAMLINE NUMBER - IIS
C
  310 DO 850 IIS=1,NSTR
      WRITE (06,1200) IIS
C
      SADIN=RSTAGR(IIS)
      SADINS=SSTAGR(IIS)
      SEMA=SSEMA(IIS)
      SIGS=SSIGS(IIS)
      SEMT=SSEMT(IIS)
      VWHEEL=SEMT*AO
      R=SR(IIS)
      SIGR=SSIGR(IIS)
      CHORD=SIGR
      Z=SXOCH(IIS)
      STHETA=SSTHET(IIS)
      ISTR=IIS
      CALL DRAGQ(ISTR)
      WRITE (06,1210) SCD(ISTR)
```

```
C
C=============================================
C
C SIMILARITY AND CORRELATION CALCULATIONS
C
C=============================================
C
C WAKE PARAMETERS
C
      BETA0=ATAN((1.-0.5*STHETA)*SEMT/SEMA)
      ALPHR=BETA0
      ALPHS=ATAN(0.5*STHETA*SEMT/SEMA)
C
C W(N) EVALUATED AT STATOR 1/4 CHORD POINT
C
      IF (ISTATR.NE.1) GO TO 400
      Z=Z+0.25*NBLADE/NVANE*SIGS/SIGR
  400 CONTINUE
      WT00=SEMA/(SEMT*COS(BETA0))
      BNB=FLOAT(NBLADE)
C
      SDIST=Z/COS(BETA0)
      CALL WAKE1 (IWAKE,CD,SDIST,WT00,ALPHR,BETA0,SIGR,WTDC,DL0)
      CALL TURBVL (CD,SDIST,WT00,UVT,WTT)
      IF (IPRNT.LE.0) GO TO 500
      GO TO (410,420,430), IWAKE
C
  410 WRITE (06,1300)
      GO TO 440
  420 WRITE (06,1310)
      GO TO 440
  430 WRITE (06,1320)
C
  440 CONTINUE
      WRITE (06,1330) WT00
      WRITE (06,1340) WTDC
      WRITE (06,1350) SDIST
      WRITE (06,1360) DL0
      WRITE (06,1370) UVT
      WRITE (06,1380) WTT
C
C=================================================
C
C DETERMINE RELATIVE,ABSOLUTE,AND PERTURBATION VELOCITIES
C
C=================================================
C
C SPECIFY ANALYSIS TRAVERSE DISTANCE STEP SIZE
C
  500 RN=FLOAT(N)
      NPS=(N-1)/2
      S=2.*PI/BNB
      NI=N-1
      RNI=FLOAT(NI)
      SI=S/RNI
      RNPS=FLOAT(NPS)
```

```
      THETA(1)=-RNPS*SI
      ST(1)=THETA(1)/(2.*ABS(THETA(1)))
C
      DO 510 I=2,N
      THETA(I)=THETA(I-1)+SI
      ST(I)=THETA(I)/(2.*ABS(THETA(1)))
  510 CONTINUE
C
C DETERMINE INVISCID DISTRIBUTION OF WT
C
      BETA0=BETA0*DTR
      WTINC=WTIV/RNI
      WT0(1)=WT00
      WTIF(1)=1.0
      ND2=(N+1)/2
      N22=ND2+1
      DO 520 I=2,ND2
      WTIF(I)=WTIF(I-1)-WTINC
  520 CONTINUE
      DO 530 I=N22,N
      WTIF(I)=WTIF(1)+WTIV/2.+(N22-I)*WTINC
  530 CONTINUE
C
C DETERMINE TANGENTIAL ANGLE DISTRIBUTION
C
      BETAW=BETAW*DTR
      BETA(1)=BETA0
      DO 540 I=2,N
      BETA(I)=BETA(1)
  540 CONTINUE
C
      IMIDDL=(N+1)/2
      DO 550 I=1,IMIDDL
C
C SPECIFY EXIT-FLOW TOTAL RELATIVE VELOCITY PROFILE
C
      DLSPP=DL0*S
      DLSOP=DLSPP/2.
      DL=DLSOP
      DT=THETA(I)/DL
      DT1=(THETA(I)+S)/DL
C
      CALL WAKE2 (IWAKE,ISHAPE,DT,PP)
      WT(I)=WTDC*(1.-PP)
      WT(I)=WT(I)*WTIF(I)+WT0(1)-WTDC
      II=I
      BETA(I)=BETA(I)+BETAW*EXP(PP)
      CALL WAKE2 (IWAKE,ISHAPE,DT1,PP1)
      PPT=PP+PP1
      WTOT(I)=WTDC*(1.-PPT)
      WTOT(I)=WTOT(I)*WTIF(I)+WT0(1)-WTDC
      UVTI(I)=UVT
      WTI(I)=WTT
  550 CONTINUE
C
C CALCULATE RELATIVE VELOCITY COMPONENTS
```

```
C    BETDEL=BETA(I)-BETA(1)
C    WS(I)=WT(I)*COS(BETDEL)
C    WN(I)=WT(I)*SIN(BETDEL)
C
       IMIDL1=IMIDDL+1
       DEL=WTOT(IMIDDL)-WT(IMIDDL)
       DO 560 I=IMIDL1,N
       DT=THETA(I)/DL
       DT1=(THETA(I)-S)/DL
       CALL WAKE2 (IWAKE,ISHAPE,DT,PP)
       WT(I)=WTDC*(1.-PP)
       WT(I)=WT(I)*WTIF(I)+WTO(1)-WTDC
       BETA(I)=BETA(I)+BETAW*EXP(PP)
       CALL WAKE2 (IWAKE,ISHAPE,DT1,PP1)
       PPT=PP+PP1
       WTOT(I)=WTDC*(1.-PPT)
       WTOT(I)=WTOT(I)*WTIF(I)+WTO(1)-WTDC
       II=I
       UVTI(I)=UVT
       WTI(I)=WTT
  560 CONTINUE
C
       DO 570 I=1,N
       WTOT(I)=WTOT(I)-DEL
       BETDEL=BETA(I)-BETA(1)
       WS(I)=WTOT(I)*COS(BETDEL)
       WN(I)=WTOT(I)*SIN(BETDEL)
       II=I
  570 CONTINUE
C
       IF (ITPVTX.EQ.0.AND.IHBVTX.EQ.0) GO TO 600
C
C CALCULATE VORTEX INDUCED VELOCITY FIELD
C
       CALL VORTX2 (ISTR)
C
C INTEGRATE WAKE AND VORTEX GUST DESCRIPTIONS
C
  600 NO=(N-1)/2
       N1=(N+1)/2
       DO 610 I=1,N1
       IF (ITPVTX.EQ.0.AND.IHBVTX.EQ.0) VISRV(I)=0.
       IF (ITPVTX.EQ.0.AND.IHBVTX.EQ.0) VINRV(I)=0.
       WSC(I)=VISRV(I)+WS(NO+I)
       WNC(I)=VINRV(I)+WN(NO+I)
  610 CONTINUE
C
       N2=2*NO
       DO 620 I=N1,N
       IF (ITPVTX.EQ.0.AND.IHBVTX.EQ.0) VISRV(I)=0.
       IF (ITPVTX.EQ.0.AND.IHBVTX.EQ.0) VINRV(I)=0.
       WSC(I)=VISRV(I)+WS(I-NO)
       WNC(I)=VINRV(I)+WN(I-NO)
  620 CONTINUE
C
       N3=2*N-1
```

```
      DO 630 I=N,N3
      WSC(I)=WSC(I-N2)
      WNC(I)=WNC(I-N2)
      UVTI(I)=UVTI(I-N2)
      WTI(I)=WTI(I-N2)
  630 CONTINUE
C
      DO 640 I=1,N3
      WS(I)=WSC(I)
      WN(I)=WNC(I)
      WT(I)=(WSC(I)**2+WNC(I)**2)**0.5
      AAA=WS(I)/WT(I)
      IF (AAA.GE.1.0) AAA=1.0
      BETA(I)=ARCOS(AAA)+BETA0
      RLI=FLOAT(I)
      RLN3=FLOAT(N3)
      ST(I)=(RLI-1.)/(RLN3-1.)
      ST(I)=ST(I)*2.
  640 CONTINUE
C
      DO 650 I=N,N3
      THETA(I)=THETA(I-N2)
  650 CONTINUE
C
      WTHN1=WT(N1)*SIN(BETA(N1))
      WXN1=WT(N1)*COS(BETA(N1))
      VXN1=WXN1
      VTHN1=1.+VVTR-WTHN1
      VTN1=(VXN1**2+VTHN1**2)**0.5
      ALPHA(N1)=ARCOS(VXN1/VTN1)
      ALPDN1=ALPHA(N1)-ALPHA(N1)
      VS(N1)=VTN1*COS(ALPDN1)
C
      DO 660 I=1,N3
C
C DETERMINE ABSOLUTE VELOCITY PROFILE
C
      WTH=WT(I)*SIN(BETA(I))
      WX=WT(I)*COS(BETA(I))
      VX=WX
      VTH=1.0+VVTR-WTH
      VT(I)=(VX**2+VTH**2)**0.5
      ALPHA(I)=ARCOS(VX/VT(I))
C
C DETERMINE ABSOLUTE VELOCITY COMPONETS
C
      ALPDEL=ALPHA(N1)-ALPHA(I)
      VS(I)=VT(I)*COS(ALPDEL)
      VN(I)=VT(I)*SIN(ALPDEL)
C
C     DETERMINE TOTAL PERTURBATION VELOCITY
C
      VPN(I)=VN(I)
      VPS(I)=VS(I)-VS(N1)
      VTP(I)=(VPS(I)**2+VPN(I)**2)**0.5
C
```

```
  660 CONTINUE
C
      DO 670 I=1,N
      VINRV(I)=0.0
      VISRV(I)=0.0
  670 CONTINUE
C
C=====================================================
C
C PRINT NUMERICAL VELOCITY PROFILES
C
C=====================================================
C
      DO 700 I=1,N3
      THETA(I)=THETA(I)*RTD
      BETA(I)=BETA(I)*RTD
      ALPHA(I)=ALPHA(I)*RTD
  700 CONTINUE
C
      IF (WOPT.EQ.0.0) GO TO 800
      IF (IPRNT.LE.0) GO TO 800
C
      WRITE (06,1400) NCASE
      WRITE (06,1410)
      WRITE (06,1420)
      DO 710 I=1,N3,10
      WRITE (06,1430) I,THETA(I),ST(I),WT(I),WS(I),WN(I),BETA(I)
  710 CONTINUE
C
      WRITE (06,1500)
      WRITE (06,1510)
      DO 720 I=1,N3,10
      WRITE (06,1430) I,THETA(I),ST(I),VT(I),VS(I),VN(I),ALPHA(I)
  720 CONTINUE
C
      WRITE (06,1600)
      WRITE (06,1610)
      DO 730 I=1,N3,10
      WRITE (06,1620) I,THETA(I),ST(I),VTP(I),VPS(I),VPN(I)
  730 CONTINUE
C
      WRITE (06,1700)
      WRITE (06,1710)
      DO 740 I=1,N3,10
      WRITE (06,1720) I,THETA(I),ST(I),UVTI(I),WTI(I)
  740 CONTINUE
C
C=============================================================
C
C CALCULATE HARMONIC CONTENT OF ROTOR EXIT FLOW
C
C=============================================================
C
  800 IF (FOPT.NE.1.0) GO TO 810
      CALL HRMNIC (ISTR,N,NHT,VREF,VWHEEL)
C
```

```
C=======================================================
C
C CALCULATE AXISYMMETRIC TURBULENCE SPECTRUM
C
C=======================================================
C
  810 IF (ITURB.NE.1) GO TO 850
      CALL TBSPCT (ISTR,NBLADE,NVANE,AO,RWALL,R,DLO,
     & UVT,WTT,VREF,VWHEEL)
C
  850 CONTINUE
C
      IF (FOPT.NE.1.0) GO TO 960
      WRITE (06,2000)
      DO 920 ISL=1,NSTR
      WRITE (06,2010) ISL
      WRITE (06,2020)
      DO 900 NH=1,NHT
      WRITE (06,2030) NH,FCA(NH,ISL),FCB(NH,ISL),FCDB(NH,ISL)
  900 CONTINUE
C
      SADIN=RSTAGR(ISL)
      SADIN=SADIN*PI/180.0
      R=SR(ISL)
      SEMA=SSEMA(ISL)
      SEMT=SSEMT(ISL)
      SIGR=SSIGR(ISL)
      SIGS=SSIGS(ISL)
      CHORD=SIGR
      Z=SXOCH(ISL)
      IF (ISTATR.NE.1) GO TO 910
      Z=Z+0.25*NBLADE/NVANE*SIGS/SIGR
  910 CONTINUE
      STHETA=SSTHET(ISL)
      BETA2=ATAN((1.-STHETA)*SEMT/SEMA)
      PHIO=CHORD*SIN(SADIN)/(2.*R)
      DPHI=Z*TAN(BETA2)/R
      PHI(ISL)=PHIO+DPHI
      PBLADE=2.*PI/NBLADE
      PLAG(ISL)=PHI(ISL)-PHI(1)
      PLAG(ISL)=PLAG(ISL)/PBLADE
  920 CONTINUE
C
      WRITE (06,2100)
      WRITE (06,2110)
      DO 930 ISL=1,NSTR
      WRITE (06,2120) ISL,PLAG(ISL)
  930 CONTINUE
C
      IF (ITURB.NE.1) GO TO 960
      WRITE (06,2200)
      DO 950 ISL=1,NSTR
      ISLL=ISL
      WRITE (06,2210) ISL
      WRITE (06,2230)
      DO 940 I=1,NFREQ,9
```

```
      IFREQ=I
      FREQI=DELFRQ*IFREQ
      WRITE (06,2240) IFREQ,FREQI,RELDBT(ISLL,IFREQ)
  940 CONTINUE
  950 CONTINUE
  960 CONTINUE
C
      IF (NCASE.LT.KASE) GO TO 200
      GO TO 990
C
C NAMELIST ERROR
C
  980 WRITE (06,8000)
C
C FORMAT STATEMENTS
C
 1000 FORMAT (//1X,'NAMELIST INPUT FOR ROTOR WAKE/VORTEX ',
     & 'FLOW PROGRAM'/)
 1010 FORMAT (20A4)
 1100 FORMAT (////19X,'ROTOR WAKE/VORTEX FLOW PROGRAM')
 1110 FORMAT (/2X,'CASE NUMBER',I4)
 1120 FORMAT (/2X,'NEITHER TIP NOR HUB VORTEX')
 1200 FORMAT (////2X,'*** STREAMLINE NUMBER',I3,' ***')
 1210 FORMAT (/5X,'CD =',F8.4)
 1300 FORMAT (/2X,'LINEAR RATIONAL FUNCTION ROTOR WAKE PROFILE')
 1310 FORMAT (/2X,'SILVERSTEIN / KEMP & SEARS WAKE DESCRIPTION')
 1320 FORMAT (/2X,'MUGRIDGE & MORFEY WAKE DESCRIPTION')
 1330 FORMAT (5X,'WFS/UT',5X,'=',F8.4)
 1340 FORMAT (5X,'WD/UT',6X,'=',F8.4)
 1350 FORMAT (5X,'SDIST',6X,'=',F8.4)
 1360 FORMAT (5X,'WAKE WIDTH',1X,'=',F8.4)
 1370 FORMAT (5X,'UVT',8X,'=',F8.4)
 1380 FORMAT (5X,'WTT',8X,'=',F8.4)
 1400 FORMAT (///2X,'ROTOR WAKE GUST DESCRIPTION FOR CASE',I4)
 1410 FORMAT (/5X,'RELATIVE VELOCITY PROFILE')
 1420 FORMAT (/9X,'I',5X,'THETA',5X,'S',8X,'WT',7X,'WS',7X,
     & 'WN',7X,'BETA')
 1430 FORMAT (7X,I4,F9.2,4F9.5,F11.5)
 1500 FORMAT (/5X,'ABSOLUTE VELOCITY PROFILE')
 1510 FORMAT (/9X,'I',5X,'THETA',5X,'S',8X,'VT',7X,'VS',7X,'VN',
     & 6X,'ALPHA')
 1600 FORMAT (/5X,'PERTURBATION VELOCITY PROFILE')
 1610 FORMAT (/9X,'I',5X,'THETA',5X,'S',7X,'VPT',6X,'VPS',6X,
     & 'VPN')
 1620 FORMAT (7X,I4,F9.2,4F9.5)
 1700 FORMAT (/5X,'TURBULENT VELOCITY PROFILE')
 1710 FORMAT (/9X,'I',5X,'THETA',5X,'S',7X,'UVTI',5X,'WTI')
 1720 FORMAT (7X,I4,F9.2,3F9.5)
 2000 FORMAT (////2X,'HARMONIC CONTENT OF ROTOR WAKE/VORTEX FLOW')
 2010 FORMAT (/5X,'STREAMLINE NUMBER',I3)
 2020 FORMAT (/8X,'NH',3X,'MODULUS',4X,'PHASE',4X,'20*LOG(MODULUS), DB')
 2030 FORMAT (7X,I3,F10.6,F11.6,F14.2)
 2100 FORMAT (//2X,'TIP-TO-HUB AERODYNAMIC PHASE LAG')
 2110 FORMAT (/5X,'STREAMLINE NO.',2X,'AERO PHASE LAG')
 2120 FORMAT (10X,I3,F19.6)
 2200 FORMAT (//2X,'TURBULENCE SPECTRUM OF ROTOR WAKE/VORTEX FLOW')
```

```
 2210 FORMAT (/5X,'STREAMLINE NUMBER',I3)
 2230 FORMAT (/8X,'IFREQ',2X,'FREQUENCY',3X,'REL DB')
 2240 FORMAT (8X,I4,F12.2,F9.2)
 8000 FORMAT (//2X,'ERROR READING NAMELIST INPUT')
C
  990 STOP
      END
C
C DRAGQ
C SUBROUTINE TO COMPUTE DRAG COEFFICIENT (CD)
C
      SUBROUTINE DRAGQ (IS)
C
      COMMON /FAN/ SEMA,SEMT,STHETA,SIGR,SADINS
      COMMON /DRAG/ ICD,CD,WR,SCD(21),SWR(21)
C
      IF (ICD.GT.1) GO TO 100
      CD=SCD(IS)
      GO TO 500
C
  100 CONTINUE
      BETA1=ATAN(SEMT/SEMA)
      BETA2=ATAN((1.-STHETA)*SEMT/SEMA)
      BETAM=ATAN((TAN(BETA1)+TAN(BETA2))/2.)
C
      IF (ICD.GT.2) GO TO 200
      WR=SWR(IS)
      CD=WR*(COS(BETAM)**3)/(SIGR*COS(BETA1)**2)
      SCD(IS)=CD
      GO TO 500
C
  200 DF=(1.0-COS(BETA1)/COS(BETA2))+
     & COS(BETA1)*((TAN(BETA1)-TAN(BETA2))/(2.0*SIGR))
C
      IF (IS.NE.1) GO TO 300
      WRFCTR=0.2911*DF**2-0.0357*DF+0.004
      GO TO 400
C
  300 CONTINUE
      WRFCTR=0.0706*DF**2-0.0030*DF+0.0038
C
  400 WR=WRFCTR*2.0*SIGR/COS(BETA2)
      SWR(IS)=WR
      CD=WR*(COS(BETAM)**3)/(SIGR*COS(BETA1)**2)
      SCD(IS)=CD
C
  500 CONTINUE
      RETURN
C
C END OF SUBROUTINE DRAGQ
      END
C
C WAKE1
C SUBROUTINE TO CALCULATE WAKE CENTERLINE DEFECT AND SEMI-WAKE WIDTH
C
      SUBROUTINE WAKE1 (IWAKE,CD,SDIST,WT00,ALPHR,BETA0,SIGR,WTDC,DL0)
```

```
C
      PI=4.0*ATAN(1.)
      GO TO (100,200,300), IWAKE
C
C LINEAR RATIONAL FUNCTION FOR ROTOR WAKE PROFILE
C
  100 CONTINUE
      CDEXP1=CD**(0.125)
      CDEXP2=CD**(0.25)
      DL0=((0.31875*SDIST*CDEXP1+0.048)/
     & (0.268125*SDIST*CDEXP1+1.0))
      WTDC=CDEXP2*((0.3675*SDIST+1.95)/(7.65*SDIST+1.0))
      GO TO 400
C
C SILVERSTEIN/KEMP & SEARS WAKE PROFILE
C
  200 CONTINUE
      WTDC=SQRT(CD)*(1.21*(SDIST+0.3)**(-1.0))
      DL0=SQRT(CD)*SIGR*(0.68*(SDIST+0.15)**0.5)
      GO TO 400
C
C MUGRIDGE & MORFEY WAKE PROFILE
C
  300 CONTINUE
      A1A=2.0
      WTDC=SQRT(CD)*A1A/SQRT(2.)*((SDIST+2.*CD)**(-0.5))
      DL0=CD*SIGR*(0.5+EXP(-0.16/CD*SDIST))*(WTDC)**(-1.0)
C
  400 CONTINUE
      IF (IWAKE.GT.1) DL0=DL0/COS(ALPHR)
      WTDC=WTDC*WT00
      IF (DL0.GE.0.5) DL0=0.5
      BETA0=BETA0*180./PI
      RETURN
C
C END OF SUBROUTINE WAKE1
      END
C
C WAKE2
C SUBROUTINE TO CALCULATE TANGENTIAL WAKE PROFILE
C
      SUBROUTINE WAKE2 (IWAKE,ISHAPE,DT,PP)
C
      PI=4.0*ATAN(1.)
      GO TO (100,200,300), IWAKE
C
C LINEAR RATIONAL FUNCTION FOR ROTOR WAKE PROFILE
C
  100 CONTINUE
      GO TO (110,120), ISHAPE
  110 PP=2./(EXP(1.3169579*DT)+EXP(-1.3169579*DT))
      GO TO 400
  120 PP=EXP(-0.6931472*DT*DT)
      GO TO 400
C
C SILVERSTEIN/KEMP & SEARS WAKE PROFILE
```

```
C
  200 CONTINUE
      GO TO (210,220), ISHAPE
  210 PP=2./(EXP(PI*DT/2.)+EXP(-PI*DT/2.))
      GO TO 400
  220 PP=EXP(-PI*DT*DT/4.)
      GO TO 400
C
C MUGRIDGE & MORFEY WAKE PROFILE
C
  300 CONTINUE
      GO TO (310,320), ISHAPE
  310 PP=2./(EXP(PI*DT/2.)+EXP(-PI*DT/2.))
      GO TO 400
  320 PP=EXP(-PI*DT*DT/4.)
C
  400 CONTINUE
      IF (PP.LT.1.E-20) PP=1.E-20
      RETURN
C
C END OF SUBROUTINE WAKE2
      END
C
C TURBVL
C SUBROUTINE TO COMPUTE PEAK TURBULENT VELOCITY COMPONENTS
C AT REQUIRED STREAMWISE DISTANCE
C
      SUBROUTINE TURBVL (CD,SDIST,WT00,UVT,WTT)
C
C AXIAL (U) AND TANGENTIAL (V) TURBULENT VELOCITY COMPONENTS
C HAVE BEEN GROUPED TOGETHER AND CORRELATED, WHEREAS, RADIAL (W)
C TURBULENT VELOCITY COMPONENT IS CORRELATED BY ITSELF
C
      UVT=(425.0*SDIST*CD**1.5+0.18)/(12500.0*SDIST*CD**1.5+1.0)
      WTT=(345.0*SDIST*CD**1.5+0.264)/(8625.0*SDIST*CD**1.5+1.0)
      UVT=UVT*WT00
      WTT=WTT*WT00
      RETURN
C
C END OF SUBROUTINE TURBVL
      END
C
C VORTX1
C SUBROUTINE VORTX1 COMPUTES VORTEX STRENGTH AND RADIUS OF
C TIP AND HUB VORTICES
C
      SUBROUTINE VORTX1
C
      COMMON /FANVTX/ NSTR,SSIGR(21),SSEMA(21),SSTHET(21),SSEMT(21)
      COMMON /VTEX1/ ITPVTX,IHBVTX,TAU,ALPHR,CHORD,WT00
      COMMON /VTEX2/ SAODS(2),SCIRC0(2),SO0(2),SVSDV0(2),SCL(2),
     & SFRL(2)
C
      PI=4.0*ATAN(1.)
      IF (ITPVTX.EQ.0) GO TO 100
C
```

```
      SIGR=SSIGR(1)
      SEMA=SSEMA(1)
      STHETA=SSTHET(1)
      SEMT=SSEMT(1)
      BETA0=ATAN((1.-0.5*STHETA)*SEMT/SEMA)
      ALPHR=BETA0
      CHORD=SIGR
      WT00=SEMA/(SEMT*COS(BETA0))
      FRLT=0.23+7.45*TAU*SIGR
      SEMR=SEMA/COS(ALPHR)
      CLT=2.0*SEMT*STHETA/(SEMR*SIGR)
      ADTAUT=0.14*((1./TAU)*SQRT(CLT))**0.85
      AODST=ADTAUT*TAU*SIGR
      CIRC0T=FRLT*CLT/2.*CHORD*WT00
      00T=CIRC0T/(AODST*2.*PI)
      G10=4.*0.693*1.0*CHORD
      G11=G10/(TAU*(ADTAUT**2.))
      G12=G11/(CHORD*TAU)
      G1=ALOG(G12)
      VSDV0T=0.5*((00T)**2)*SEMT/SEMR*G1
      G21=CLT*CHORD*WT00*FRLT/(4.*PI)
      SAODS(1)=AODST
      SCIRC0(1)=CIRC0T
      S00(1)=00T
      SVSDV0(1)=VSDV0T
      SCL(1)=CLT
      SFRL(1)=FRLT
      GO TO 200
C
  100 SAODS(1)=0.0
      SCIRC0(1)=0.0
      S00(1)=0.0
      SVSDV0(1)=0.0
      SCL(1)=0.0
      SFRL(1)=0.0
      WRITE (06,1000)
C
  200 IF (IHBVTX.EQ.0) GO TO 300
      SIGR=SSIGR(NSTR)
      SEMA=SSEMA(NSTR)
      STHETA=SSTHET(NSTR)
      SEMT=SSEMT(NSTR)
      BETA0=ATAN((1.-0.5*STHETA)*SEMT/SEMA)
      ALPHR=BETA0
      CHORD=SIGR
      WT00=SEMA/(SEMT*COS(BETA0))
      FRLH=0.2
      SEMR=SEMA/COS(ALPHR)
      CLH=2.0*SEMT*STHETA/(SEMR*SIGR)
      AODSH=0.2*SIGR
      CIRC0H=FRLH*CLH/2.*CHORD*WT00
      00H=CIRC0H/(AODSH*2.*PI)
      VSDV0H=0.2
      SAODS(2)=AODSH
      SCIRC0(2)=CIRC0H
      S00(2)=00H
```

```
      SVSDV0(2)=VSDV0H
      SCL(2)=CLH
      SFRL(2)=FRLH
      GO TO 400
C
  300 SAODS(2)=0.0
      SCIRC0(2)=0.0
      SO0(2)=0.0
      SVSDV0(2)=0.0
      SCL(2)=0.0
      SFRL(2)=0.0
      WRITE (06,1100).
C
  400 CONTINUE
C
C FORMAT STATEMENTS
C
 1000 FORMAT(//5X,'NO TIP VORTEX')
 1100 FORMAT(//5X,'NO HUB VORTEX')
C
      RETURN
C
C END OF SUBROUTINE VORTX1
      END
C
C VORTX2
C SUBROUTINE VORTX2 COMPUTES THE VELOCITY FIELD INDUCED BY
C TIP AND HUB VORTICES AT ALL RADIAL LOCATIONS
C
      SUBROUTINE VORTX2 (IS)
C
      COMMON /FAN/ SEMA,SEMT,STHETA,SIGR,SADINS
      COMMON /FANVTX/ NSTR,SSIGR(21),SSEMA(21),SSTHET(21),SSEMT(21)
      COMMON /VTEX1/ ITPVTX,IHBVTX,TAU,ALPHR,CHORD,WT00
      COMMON /VTEX2/ SAODS(2),SCIRC0(2),SO0(2),SVSDV0(2),SCL(2),
     & SFRL(2)
      COMMON /VTEX3/ SBN(2),SBR(2),SDIST,N,RAWDS,R,VINRVT(300,2),
     & VISRVT(300,2),HTR,VINRV(300),VISRV(300),NBLADE
C
      DIMENSION ANL(300),SYO(2)
C
      PI=4.0*ATAN(1.0)
      FNBLAD=FLOAT(NBLADE)
C
      IF (ITPVTX.EQ.0.OR.IHBVTX.EQ.0) GO TO 100
      NVORTX=2
      SYO(1)=0.0
      FNBLAD=FLOAT(NBLADE)
      SYO(2)=RAWDS-HTR*FNBLAD/(2.*PI)
      GO TO 200
C
  100 NVORTX=1
      IF (ITPVTX.EQ.0) GO TO 110
      SYO(1)=0.0
      SYO(2)=0.0
      GO TO 200
```

```
C
  110 SYO(1)=RAWDS-HTR*FNBLAD/(2.*PI)
      SYO(2)=0.0
      SAODS(1)=SAODS(2)
      SCIRC0(1)=SCIRC0(2)
      SO0(1)=SO0(2)
      SVSDV0(1)=SVSDV0(2)
      SCL(1)=SCL(2)
      SFRL(1)=SFRL(2)
      SBN(1)=SBN(2)
C
  200 CONTINUE
      DO 500 IVORTX=1,NVORTX
      AODS=SAODS(IVORTX)
      CIRC0=SCIRC0(IVORTX)
      O0=SO0(IVORTX)
      VSDV0=SVSDV0(IVORTX)
      CL=SCL(IVORTX)
      FRL=SFRL(IVORTX)
      BN=SBN(IVORTX)
      YO=SYO(IVORTX)
      A=AODS*SQRT(SDIST+1.0)
C
      IF (ITPVTX.EQ.1.AND.IHBVTX.EQ.1) GO TO 220
      IF (ITPVTX.EQ.0) GO TO 210
      BR=A+TAU*SIGR
      SBR(1)=BR
      WRITE (06,1000)
      GO TO 250
C
  210 BR=YO-A
      SBR(1)=BR
      WRITE (06,1010)
      GO TO 250
C
  220 IF (IVORTX.EQ.1) GO TO 230
      BR=YO-A
      SBR(2)=BR
      WRITE (06,1010)
      GO TO 250
C
  230 BR=A+TAU*SIGR
      SBR(1)=BR
      WRITE (06,1000)
C
  250 CONTINUE
      CIRC=CIRC0*(SDIST+1.0)**(-0.5)
      VSDV=VSDV0*(SDIST+1.0)**(-1.0)
      WRITE (06,1110) CL
      WRITE (06,1120) FRL
      WRITE (06,1130) AODS
      WRITE (06,1140) A
      WRITE (06,1150) VSDV0
      WRITE (06,1160) VSDV
      WRITE (06,1170) CIRC0
      WRITE (06,1180) CIRC
```

```
      WRITE (06,1190) OO
      WRITE (06,1200) BN
      WRITE (06,1210) BR
C
      RN=FLOAT(N)
      RNI=RN-1.0
      SANL=1./RNI
      ANL(1)=0.0
      DO 300 I=2,N
      ANL(I)=ANL(I-1)+SANL
  300 CONTINUE
C
      ARL=RAWDS*(1.-R)
      DO 420 I=1,N
C
C     FORCED OR FREE VORTEX?
C
      RNVL=BN-ANL(I)
      RRVL=BR-ARL
      RAL=(RNVL**2+RRVL**2)**0.5
      IF (RAL.LT.A) GO TO 400
C
C FREE VORTEX NORMAL VELOCITY CALCULATION
C
      VM=2.*PI*(ARL-YO-BR)
      VNN=2.*PI*(ARL-YO+BR)
      XN=2.*PI*(ANL(I)-BN)
      D1=COSH(VM)-COS(XN)
      D2=COSH(VNN)-COS(XN)
      VINRVT(I,IVORTX)=-CIRC*1.0/2.*(SINH(VM)/D1-SINH(VNN)/D2)
      VINRVT(I,IVORTX)=VINRVT(I,IVORTX)*SSEMT(1)/SEMT
      GO TO 410
C
C FORCED VORTEX NORMAL VELOCITY CALCULATIOIN
C
  400 IF (RNVL.GT.RAL) RNVL=RAL
      THETAV=ARCOS(RNVL/RAL)
      XO=A*COS(THETAV)
      YO=A*SIN(THETAV)
      IF (ARL.GT.BR) Y1=YO+BR
      IF (ARL.LE.BR) Y1=BR-YO
      X1=BN-XO
C
      VM=2.*PI*(Y1-YO-BR)
      VNN=2.*PI*(Y1-YO+BR)
      XN=2.*PI*(X1-BN)
      D1=COSH(VM)-COS(XN)
      D2=COSH(VNN)-COS(XN)
      VINPRF=-CIRC*1.0/2.*(SINH(VM)/D1-SINH(VNN)/D2)
      VINRVT(I,IVORTX)=(RAL/A)*VINPRF
      VINRVT(I,IVORTX)=VINRVT(I,IVORTX)*SSEMT(1)/SEMT
C
C VORTEX STREAMWISE VELOCITY CALCULATION
C
  410 CONTINUE
      PP=-0.693*((RAL/A)**2)
```

```
      IF (PP.LT.-40.) PP=-40.
      VISRVT(I,IVORTX)=-VSDV*EXP(PP)
      VISRVT(I,IVORTX)=VISRVT(I,IVORTX)*SSEMT(1)/SEMT
C
  420 CONTINUE
  500 CONTINUE
C
      DO 510 I=1,N
      DO 510 IVORTX=1,NVORTX
      VINRV(I)=VINRV(I)+VINRVT(I,IVORTX)
      VISRV(I)=VISRV(I)+VISRVT(I,IVORTX)
  510 CONTINUE
C
C FORMAT STATEMENTS
C
 1000 FORMAT (///2X,'TIP VORTEX PARAMETERS')
 1010 FORMAT (///2X,'HUB VORTEX PARAMETERS')
 1110 FORMAT (5X,'CL',10X,'=',F8.4)
 1120 FORMAT (5X,'FRL',9X,'=',F8.4)
 1130 FORMAT (5X,'A0/S',8X,'=',F8.4)
 1140 FORMAT (5X,'A/S',9X,'=',F8.4)
 1150 FORMAT (5X,'VSDV0/U',5X,'=',F8.4)
 1160 FORMAT (5X,'VSDV/U',6X,'=',F8.4)
 1170 FORMAT (5X,'CIRC0/(S*U)',1X,'=',F8.4)
 1180 FORMAT (5X,'CIR/(S*U)',3X,'=',F8.4)
 1190 FORMAT (5X,'OA0/U',7X,'=',F8.4)
 1200 FORMAT (5X,'BN',10X,'='F8.4)
 1210 FORMAT (5X,'BR',10X,'='F8.4)
C
      RETURN
C
C END OF SUBROUTINE VORTX2
      END
C
C HRMNIC
C SUBROUTINE HRMNIC COMPUTES HARMONIC CONTENT OF ROTOR
C WAKE/VORTEX FLOW AT 1/4 CHORD POINT OF SATTOR
C
      SUBROUTINE HRMNIC (ISTR,N,NHT,VREF,VWHEEL)
C
      COMMON /HMONIC/ ST(300),VPN(300),FCA(30,21),FCB(30,21),FCDB(30,21)
C
      COMPLEX CSUM,CPWR,CERC
C
      PI=4.*ATAN(1.)
      RN=FLOAT(N)
      NS=(N+1)/2
      NF=NS+N-1
C
      DO 100 I=NS,NF
      ST(I)=ST(I)-0.5
  100 CONTINUE
C
      WRITE (06,1000)
      WRITE (06,1020)
C
```

```
      DO 220 NH=1,NHT
      RNH=FLOAT(NH)
      CSUM=CMPLX(0.0,0.0)
      HD3=(ST(NF)-ST(NS))/(3.*(RN-1.))
      ICH=1
C
C NUMERICAL INTERGRATION - SIMPSON'S RULE
C
      DO 210 I=NS,NF
      ICH=ICH*(-1)
      CPOE=RNH*PI*ST(I)/0.5
      CPWR=CMPLX(0.0,CPOE)
      CERC=CEXP(CPWR)
C
      IF (I.EQ.NS.OR.I.EQ.NF) GO TO 200
      CSUM=CSUM+VPN(I)*CERC*(3+ICH)
      GO TO 210
  200 CSUM=CSUM+VPN(I)*CERC
  210 CONTINUE
C
      CSUM=CSUM*HD3
C
      CMOD=CABS(CSUM)
      ARPC=REAL(CSUM)
      BIPC=AIMAG(CSUM)
      PHASE=ATAN(BIPC/ARPC)
      FCA(NH,ISTR)=CMOD
      FCB(NH,ISTR)=PHASE
      FCDB(NH,ISTR)=20.0*ALOG10(CMOD)
      FCDB(NH,ISTR)=FCDB(NH,ISTR)+20.0*ALOG10(VWHEEL/VREF)
C
      WRITE (06,1030) NH,FCA(NH,ISTR),FCB(NH,ISTR),FCDB(NH,ISTR)
  220 CONTINUE
C
C
C RESCALE INTEGRATION INTERVAL
C
      DO 300 I=NS,NF
      ST(I)=ST(I)+0.5
  300 CONTINUE
C
C FORMAT STATEMENTS
C
 1000 FORMAT (///2X,'HARMONIC CONTENT OF ROTOR WAKE/VORTEX FLOW')
 1020 FORMAT (/8X,'NH',3X,'MODULUS',4X,'PHASE',4X,
     & '20*LOG(MODULUS), DB')
 1030 FORMAT (7X,I3,F10.6,F11.6,F14.2)
C
      RETURN
C
C END OF SUBROUTINE HRMNIC
      END
C
C TBSPCT
C SUBROUTINE TBSPCT COMPUTES THE AXISYMMETRIC TURBULENCE
C SPECTRUM AT 1/4 CHORD POINT OF STATOR
```

```
C
      SUBROUTINE TBSPCT (ISTR,NBLADE,NVANE,AO,RWALL,R,DLO,
     & UVT,WTT,VREF,VWHEEL)
C
      COMMON /FAN/ SEMA,SEMT,STHETA,SIGR,SADINS
      COMMON /TURB/ NFREQ,DELFRQ,RELDBT(21,200)
C
      REAL LA,LT,K1,K1BAR
C
      PI=4.0*ATAN(1.)
      LA=0.25*DLO
      LT=0.25*DLO
      SADINS=SADINS*PI/180.0
      RD=R*RWALL
      UT=SEMT*AO
      RPM=UT*60.0/(2.0*PI*RD)
      BPF=NBLADE*RPM/60.0
C
      WRITE (06,1000)
      WRITE (06,1010) RD
      WRITE (06,1020) UT
      WRITE (06,1030) RPM
      WRITE (06,1040) BPF
C
      DUVT=UVT*UT
      DWTT=WTT*UT
      RPITCH=2.0*PI*RD/NBLADE
      DLA=LA*RPITCH
      DLT=LT*RPITCH
      EPSLON=2.0*(DWTT/DUVT)**2-(DLT/DLA)**2
      E=SIN(SADINS)**2+EPSLON*COS(SADINS)**2
      C1=E+3.0*(DLT/DLA)**2*COS(SADINS)**2
      C2=-6.0*(DLT/DLA)*SIN(SADINS)*COS(SADINS)
      C3=E+3.0*SIN(SADINS)**2
      FREQI=0.0
C
      DO 100 I=1,NFREQ
      FREQI=FREQI+DELFRQ
      X=2.0*PI*FREQI/AO
      K1=-X/SEMA
      D=NBLADE*RPITCH/NVANE
      K1BAR=K1*DLA
      A1=1.0+K1BAR**2
      BBAR=(DLT/D)*((X*D)/(1.0-SEMA**2))
      THETAB=ATAN(BBAR/A1)
      THETAA=-THETAB
      SINA=SIN(THETAA)
      SINB=SIN(THETAB)
      COSA=COS(THETAA)
      COSB=COS(THETAB)
      CON0=DUVT**2*DLA/(12.0*PI*A1**4)
      CON1=E+C1*K1BAR**2
      CON2=C2*K1BAR*A1
      CON3=C3*A1**3
      TERMA=CON1*((2.0+COSB**2)*SINB-(2.0+COSA**2)*SINA)
      TERMB=-CON2*(COSB**3-COSA**3)
```

```
      TERMC=CON3*(SINB**3-SINA**3)
      PHI=CON0*(TERMA+TERMB+TERMC)
      PHI=PHI/((SEMT*AO)**2*RPITCH)
      DB1=PHI*2.0*PI*DELFRQ/(SEMA*AO)
      IF (DB1.LE.0.0) GO TO 100
      RELDBT(ISTR,I)=10.0*ALOG10(DB1)
      RELDBT(ISTR,I)=RELDBT(ISTR,I)+20.0*
     & ALOG10(VWHEEL/VREF)
  100 CONTINUE
C
C FORMAT STATEMENTS
C
 1000 FORMAT (///2X,'DIMENSIONAL QUANTITIES')
 1010 FORMAT (5X,'RADIUS',6X,'=',F9.2,' FT')
 1020 FORMAT (5X,'WHEEL SPEED',1X,'=',F9.2,' FPS')
 1030 FORMAT (5X,'RPM',9X,'=',F9.2,' RPM')
 1040 FORMAT (5X,'BPF',9X,'=',F9.2,' HZ')
C
      RETURN
C
C END OF SUBROUTINE TBSPCT
      END
```

4.0 DEFINITION OF INPUT AND OUTPUT PARAMETERS

This section of Volume II defines all the input and output parameters of the Rotor Wake/Vortex Model (RWVM) computer program. Note: Streamline Number 1 should be the tip streamline.

Input Parameters

AO - Speed of sound in ambient air, fps.

BETAW - Optional parameter to account for wake flow angle variation.
Default value: None

DELFRQ - Band width for turbulence spectrum prediction, Hz.

FOPT - Option to calculate the harmonic content of the exit flow field.
FOPT=0 - No
FOPT=1 - Yes
Default value: None

HTR - Hub-tip ratio.

ICD - Drag coefficient option.
ICD=1 - Input the drag coefficient, SCD array.
ICD=2 - Calculate the drag coefficient from an input loss coefficient.
Input the SWR array.
ICD=3 - Calculate the drag coefficient from a calculated loss coefficient which is a function of the diffusion factor.
Default value: ICD=1

IHBTVX - Option to include secondary flow due to the hub vortex.
IHBVTX=0 - No
IHBVTX=1 - Yes
Default value: IHBVTX=0

ISHAPE - Wake tangential profile option.
ISHAPE=1 - Hyperbolic secant profile
ISHAPE=2 - Gaussian profile
Default value: ISHAPE=1

ISTATR - Gust velocity option.
ISTATR=0 - Calculate gust velocity at stator LE or at any point between rotor TE and stator LE.
ISTATR=1 - Calculate gust velocity at 1/4 chord point of stator.
Default value: ISTATR=1

ITPVTX - Option to include secondary flow due to the tip vortex.
ITPVTX=0 - No
ITPVTX=1 - Yes
Default value: ITPVTX=1

ITURB - Option to calculate a turbulence spectrum.
ITURB=0 - No

ITURB=1 - Yes
Default value: ITURB=1

IWAKE - Rotor velocity defect and semi-wake width model.
IWAKE=1 - Use the Linear Rational Function Model
IWAKE=2 - Use the Silverstein/Kemp & Sears Model
IWAKE=3 - Use the Mugridge & Morfey Model, coefficient=2
Default value: IWAKE=1

KASE - Case Number.

N - Number of points in the velocity profile across one blade spacing.
Maximum value: N=150

NBLADE - Number of rotor blades.

NFREQ - Number of frequencies at which the turbulence spectrum is to be calculated.
Maximum value: NFREQ=200

NHT - Number of sequential harmonics required for Fourier Analysis (IHT=1,2,3,...,NHT).
Maximum value: NHT=21

NSTR - Number of streamlines.
Maximum value: NSTR=21

NVANE - Number of stator blades.

RAWDS - Radius of the annulus wall divided by the blade spacing at the rotor tip.

RSTAGR - Stagger angle (setting angle) for the rotor, deg.
Input one value for each streamline.

RWALL - Annulus wall radius, ft.

SBN(1) - Tangential distance normalized by tip blade spacing for the tip vortex center.
Default value: SBN(1)=0.5

SBN(2) - Tangential distance normalized by hub blade spacing for the hub vortex center.
Default value: SBN(2)=0.0

SCD - Drag coefficients.
Input one value for each streamline.
Used only when ICD=1.

SR - Radius of the streamline under analysis divided by the radius of the inner surface of the annulus wall.
Input one value for each streamline.

SSEMA - Streamline axial Mach number.
Input one value for each streamline.

SSEMT - Streamline wheel speed Mach number.
Input one value for each streamline.

SSIGR - Streamline rotor solidity.
Input one value for each streamline.

SSIGS - Streamline stator solidity.
Input one value for each streamline.

SSTAGR - Stagger angle (setting angle) for the stator, deg.
Input one value for each streamline.

SSTHET - Streamline work coefficient.
Input one value for each streamline.

SWR - Loss coefficient.
Input one value for each streamline.
Used only when ICD=2.

SXOCH - Axial distance between rotor TE and stator LE.
Normalized by the rotor aero chord.
Input one value for each streamline.

TAU - Tip clearance gap.
Normalized by the rotor aero chord at the tip.

VREF - Reference velocity by which the gust upwash velocity harmonic coefficients are normalized, fps.

VVTR - Used only in the analysis of counter-rotating propellers.
VVTR must be set to 0.0 for rotor wakes impinging a stator.

WOPT - Option to print the velocity profiles.
WOPT=0 - No
WOPT=1 - Yes
Default value: None

WTIV - Inviscid velocity gradient, normalized by wheel speed.

Output Parameters

Wake Parameters

CD - Drag coefficient for the streamline.

WFS/UT - Free stream velocity divided by wheel speed.

WD/UT - Wake centerline defect divided by wheel speed.

SDIST - Streamwise distance of analysis plane aft of the rotor TE divided by the rotor aero chord.

WAKE WIDTH - Semi-wake width divided by blade spacing.

UVT - Peak turbulent velocity normalized by wheel speed in axial and tangential directions.

WTT - Peak turbulent velocity normalized by wheel speed in radial direction.

Tip Vortex Parameters

CL - Blade lift coefficient at the tip.

FRL - Fraction of lift lost to the tip vortex.

AO/S - Radius of the tip vortex core normalized by tip spacing at rotor TE.

A/S - Radius of the tip vortex core normalized by tip spacing at analysis plane.

VSDVO/U - Streamwise velocity defect of tip vortex core at rotor TE normalized by blade tip speed.

VSDV/U - Streamline velocity defect of tip vortex core at analysis plane normalized by blade tip speed.

CIRCO/(S*U) - Circulation of tip vortex core at rotor TE normalized by the product of blade spacing at the tip and blade tip speed.

CIR/(S*U) - Circulation of tip vortex core at analysis plane normalized by the product of blade spacing at the tip and blade tip speed.

OAO/U - Angular rotation of the tip vortex core at rotor TE normalized by angular rotation of the blade.

BN - Tangential location of the tip vortex normalized by tip blade spacing.

BR - Spanwise location of the tip vortex from the annulus wall normalized by tip blade spacing.

Hub Vortex Parameters

CL - Blade lift coefficient at the hub.

FRL - Fraction of lift lost to the hub vortex.

A0/S - Radius of the hub vortex core normalized by hub spacing at rotor TE.

A/S - Radius of the hub vortex core normalized by hub spacing at analysis plane.

VSDV0/U - Streamwise velocity defect of hub vortex core at rotor TE normalized by blade hub speed.

VSDV/U - Streamline velocity defect of hub vortex core at analysis plane normalized by blade hub speed.

CIRC0/(S*U) - Circulation of hub vortex core at rotor TE normalized by the product of blade spacing at the hub and blade hub speed.

CIR/(S*U) - Circulation of hub vortex core at analysis plane normalized by the product of blade spacing at the hub and blade hub speed.

OA0/U - Angular rotation of the hub vortex core at rotor TE normalized by angular rotation of the blade.

BN - Tangential location of the hub vortex normalized by hub blade spacing.

BR - Spanwise location of the hub vortex from the annulus wall normalized by hub blade spacing.

Relative Velocity Profile

All velocity profiles (relative, absolute, perturbation, and turbulent) are printed over two blade spacings.

I - Index for tangential profile.

THETA - Angular location relative to the mid-point of the blade passage, deg.

S - Tangential distance from rotor blade TE divided by blade spacing.

WT - Total relative velocity divided by wheel speed.

WS - Streamwise relative velocity divided by wheel speed.

WN - Normal relative velocity divided by wheel speed.

BETA - Flow angle of the rotor relative velocity vector to the axial direction, deg.

Absolute Velocity Profile

I - Index for tangential profile.

THETA - Angular location relative to the mid-point of the blade passage, deg.

S - Tangential distance from rotor blade TE divided by blade spacing.

VT - Total absolute velocity divided by wheel speed.

VS - Streamwise absolute velocity divided by wheel speed.

VN - Normal (upwash) absolute velocity divided by wheel speed.

ALPHA - Flow angle of the absolute velocity vector to the axial direction, deg.

Perturbation Velocity Profile

I - Index for tangential profile.

THETA - Angular location relative to the mid-point of the blade passage, deg.

S - Tangential distance from rotor blade TE divided by blade spacing.

VPT - Total perturbation velocity from the free stream in the stationary reference frame divided by wheel speed.

VPS - Streamwise perturbation velocity from the free stream in the stationary reference frame divided by wheel speed.

VPN - Normal (upwash) perturbation velocity from the free stream in the stationary reference frame divided by wheel speed.
Fourier coefficients are evaluated for this profile.

Turbulent Velocity Profile

I - Index for tangential profile.

THETA - Angular location relative to the mid-point of the blade passage, deg.

S - Tangential distance from rotor blade TE divided by blade spacing.

UVTI - Axial and tangential turbulent velocity normalized by wheel speed.

WTI - Radial turbulent velocity normalized by wheel speed.

Harmonic Content of Rotor Wake/Vortex Flow

NH - Harmonic number.

Modulus - Amplitude of complex Fourier coefficient of upwash perturbation velocity divided by wheel speed.

PHASE - Phase of the complex Fourier coefficient of upwash perturbation velocity.

20*LOG(MODULUS), DB - dB level of the amplitude of upwash perturbation velocity relative to the reference velocity, VREF, defined by:

20 log ((MODULUS * Wheel Speed)/VREF)

Dimensional Quantities

RADIUS - Radius of the streamline of interest, ft.

WHEEL SPEED - Wheel speed, fps.

RPM - Revolutions per minute, rpm.

BPF - Blade passing frequency, Hz.

Tip-to-Hub Aerodynamic Phase Lag

STREAMLINE NO. - Streamline number.
Streamline 1 should be the tip streamline.

AERO PHASE LAG - Phase lag relative to tip streamline

normalized by angular spacing of the rotor.

Turbulence Spectrum of Rotor Wake/Vortex Flow

IFREQ - Index on the broadband spectrum of turbulence.

FREQUENCY - Centerband frequency of the broadband spectrum of turbulence in Hz.

REL DB - Broadband level of turbulence relative to the reference velocity, VREF.

5.0 A SAMPLE INPUT/OUTPUT CASE

A sample input/output case enclosed in this section pertains to Rotor 55 at 80% design rpm. The rotor-stator spacing at midspan equals 0.54c. The spanwise variation is prescribed in terms of geometric and aerodynamic data at nine streamlines; the first streamline is at 5% span from the tip and the last streamline is at 95% span from the tip.

```
&INPUT
KASE=1,
VREF=10.0,
IWAKE=1,ITPVTX=1,IHBVTX=0,
ISHAPE=1,
SBN(1)=0.42,
VVTR=0.0,
N=101,
NSTR=9,
SR=.970,.943,.916,.835,.728,.620,.539,.512,.485,
SXOCH=.435,.439,.440,.475,.540,.622,.700,.728,.758,
SSIGR=.896,.905,.919,.948,.998,1.063,1.130,1.157,1.186,
RSTAGR=38.96,37.05,35.44,30.66,24.22,17.48,11.74,9.73,7.69,
SSIGS=.733,.753,.773,.841,.951,1.091,1.228,1.282,1.341,
NBLADE=15,
NVANE=25,
ICD=2,
SWR=.134,.103,.099,.047,.031,.020,.086,.129,.108,
SSTHET=.486,.481,.496,.562,.688,.830,.967,1.009,1.098,
SSEMA=.291,.317,.328,.334,.323,.314,.285,.275,.277,
SSEMT=.478,.464,.452,.413,.360,.308,.265,.253,.240,
WTIV=0.0,
BETAW=0.0,
TAU=0.009,
RAWDS=2.462,
FOPT=1.0,
NHT=5,
WOPT=1.0,
HTR=0.46,
ITURB=1,
RWALL=0.8333,
AO=1116.7,
SSTAGR=12.15,12.36,12.57,13.28,14.07,15.00,15.67,15.88,16.09,
NFREQ=200,
DELFRQ=50.0,
ISTATR=1,
&END
```

```
 * NDAY COST          $.55          $0                                        *
 * CRU COEFF.          .014        .0059                                      *
 * CRU'S.            .003122     .0000531                                     *
 *                                                                            *
 *   (+XX OR -XX MEANS MOVE DECIMAL RIGHT OR LEFT XX POSITIONS)               *
 *  TOTAL COST IN THIS REPORT: DAY =       $1.57,   NDAY =        $.55        *
 *  TOTAL CRU'S =    .0031751                                                 *
 ****************************************************************************

 IEF375I  JOB /AAME03TX/ START 84193.1742
 IEF376I  JOB /AAME03TX/ STOP  84193.1742 CPU     0MIN 03.00SEC SRB     0MIN 00.17SEC
1FORTRAN H EXTENDED COMPILER ENTERED
0*STATISTICS*      SOURCE STATEMENTS =      364, PROGRAM SIZE =    31284, SUBPROGRAM NAME =  MAIN
0*STATISTICS*  NO  DIAGNOSTICS GENERATED
0****** END OF COMPILATION ******                                  172K BYTES OF CORE NOT USED
0*STATISTICS*      SOURCE STATEMENTS =       31, PROGRAM SIZE =      832, SUBPROGRAM NAME = DRAGQ
0*STATISTICS*  NO  DIAGNOSTICS GENERATED
0****** END OF COMPILATION ******                                  248K BYTES OF CORE NOT USED
0*STATISTICS*      SOURCE STATEMENTS =       26, PROGRAM SIZE =     1138, SUBPROGRAM NAME = WAKE1
0*STATISTICS*  NO  DIAGNOSTICS GENERATED
0****** END OF COMPILATION ******                                  248K BYTES OF CORE NOT USED
0*STATISTICS*      SOURCE STATEMENTS =       25, PROGRAM SIZE =      868, SUBPROGRAM NAME = WAKE2
0*STATISTICS*  NO  DIAGNOSTICS GENERATED
0****** END OF COMPILATION ******                                  248K BYTES OF CORE NOT USED
0*STATISTICS*      SOURCE STATEMENTS =        7, PROGRAM SIZE =      424, SUBPROGRAM NAME =TURBVL
0*STATISTICS*  NO  DIAGNOSTICS GENERATED
0****** END OF COMPILATION ******                                  248K BYTES OF CORE NOT USED
0*STATISTICS*      SOURCE STATEMENTS =       78, PROGRAM SIZE =     1370, SUBPROGRAM NAME =VORTX1
0*STATISTICS*  NO  DIAGNOSTICS GENERATED
0****** END OF COMPILATION ******                                  240K BYTES OF CORE NOT USED
0*STATISTICS*      SOURCE STATEMENTS =      145, PROGRAM SIZE =     4228, SUBPROGRAM NAME =VORTX2
0*STATISTICS*  NO  DIAGNOSTICS GENERATED
0****** END OF COMPILATION ******                                  228K BYTES OF CORE NOT USED
0*STATISTICS*      SOURCE STATEMENTS =       47, PROGRAM SIZE =     1524, SUBPROGRAM NAME =HRMNIC
0*STATISTICS*  NO  DIAGNOSTICS GENERATED
0****** END OF COMPILATION ******                                  244K BYTES OF CORE NOT USED
0*STATISTICS*      SOURCE STATEMENTS =       64, PROGRAM SIZE =     1964, SUBPROGRAM NAME =TBSPCT
0*STATISTICS*  NO  DIAGNOSTICS GENERATED
0****** END OF COMPILATION ******                                  236K BYTES OF CORE NOT USED
0*STATISTICS*  NO  DIAGNOSTICS THIS STEP

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 NAMELIST INPUT FOR ROTOR WAKE/VORTEX FLOW PROGRAM

 &INPUT
 KASE=1,
 VREF=10.0,
 IWAKE=1,ITPVTX=1,IHBVTX=0,
 ISHAPE=1,
 SBN(1)=0.42,
 VVTR=0.0,
 N=101,
 NSTR=9,
 SR=.970,.943,.916,.835,.728,.620,.539,.512,.485,
 SXOCH=.435,.439,.440,.475,.540,.622,.700,.728,.758,
 SSIGR=.896,.905,.919,.948,.998,1.063,1.130,1.157,1.186,
 RSTAGR=38.96,37.05,35.44,30.66,24.22,17.48,11.74,9.73,7.69,
 SSIGS=.733,.753,.773,.841,.951,1.091,1.228,1.282,1.341,
 NBLADE=15,
 NVANE=25,
 ICD=2,
 SWR=.134,.103,.099,.047,.031,.020,.086,.129,.108,
```

```
SSTHET=.486,.481,.496,.562,.688,.830,.967,1.009,1.098,
SSEMA=.291,.317,.328,.334,.323,.314,.285,.275,.277,
SSEMT=.478,.464,.452,.413,.360,.308,.265,.253,.240,
WTIV=0.0,
BETAW=0.0,
TAU=0.009,
RAWDS=2.462,
FOPT=1.0,
NHT=5,
WOPT=1.0,
HTR=0.46,
ITURB=1,
RWALL=0.8333,
AO=1116.7,
SSTAGR=12.15,12.36,12.57,13.28,14.07,15.00,15.67,15.88,16.09,
NFREQ=200,
DELFRQ=50.0,
ISTATR=1,
&END


                    ROTOR WAKE/VORTEX FLOW PROGRAM

 CASE NUMBER    1


    NO HUB VORTEX



 *** STREAMLINE NUMBER   1 ***

    CD =   0.1361

 LINEAR RATIONAL FUNCTION ROTOR WAKE PROFILE
    WFS/UT      =   0.9714
    WD/UT       =   0.1721
    SDTST       =   0.8899
    WAKE WIDTH  =   0.2269
    UVT         =   0.0333
    WTT         =   0.0394


 TIP VORTEX PARAMETERS
    CL          =   1.1167
    FRL         =   0.2901
    AO/S        =   0.0649
    A/S         =   0.0892
    VSDVO/U     =   0.3863
    VSDV/U      =   0.2044
    CIRCO/(S*U) =   0.1410
    CIR/(S*U)   =   0.1025
    DAO/U       =   0.3460
    BN          =   0.4200
    BR          =   0.0972
```

ROTOR WAKE GUST DESCRIPTION FOR CASE 1

RELATIVE VELOCITY PROFILE

I	THETA	S	WT	WS	WN	BETA
1	-12.00	0.0	0.79992	0.79935	0.03042	53.37300
11	-9.60	0.10000	0.87404	0.87323	0.03745	53.64923
21	-7.20	0.20000	0.93671	0.93509	0.05500	54.55939
31	-4.80	0.30000	0.91072	0.90522	0.10000	57.49753
41	-2.40	0.40000	0.78455	0.77956	0.08830	57.65587
51	0.00	0.50000	0.86750	0.85779	0.12944	59.77422
61	2.40	0.60000	0.95862	0.95623	0.06777	55.24707
71	4.80	0.70000	0.96150	0.96055	0.04271	53.73917
81	7.20	0.80000	0.93852	0.93796	0.03241	53.17233
91	9.60	0.90000	0.87373	0.87325	0.02903	53.09723
101	-12.00	1.00000	0.79992	0.79935	0.03042	53.37300
111	-9.60	1.10000	0.87404	0.87323	0.03745	53.64923
121	-7.20	1.20000	0.93671	0.93509	0.05500	54.55939
131	-4.80	1.30000	0.91072	0.90522	0.10000	57.49753
141	-2.40	1.40000	0.78455	0.77956	0.08830	57.65587
151	0.00	1.50000	0.86750	0.85779	0.12944	59.77422
161	2.40	1.60000	0.95862	0.95623	0.06777	55.24707
171	4.80	1.70000	0.96150	0.96055	0.04271	53.73917
181	7.20	1.80000	0.93852	0.93796	0.03241	53.17233
191	9.60	1.90000	0.87373	0.87325	0.02903	53.09723
201	-12.00	2.00000	0.79992	0.79935	0.03042	53.37300

ABSOLUTE VELOCITY PROFILE

I	THETA	S	VT	VS	VN	ALPHA
1	-12.00	0.0	0.59661	0.59210	-0.07317	36.87785
11	-9.60	0.10000	0.59669	0.59669	0.00091	29.74583
21	-7.20	0.20000	0.59255	0.58900	0.06475	23.55995
31	-4.80	0.30000	0.54154	0.53989	0.04226	25.35764
41	-2.40	0.40000	0.53839	0.53185	-0.08368	38.77483
51	0.00	0.50000	0.50342	0.50342	0.0	29.83302
61	2.40	0.60000	0.58627	0.57969	0.08761	21.23846
71	4.80	0.70000	0.61148	0.60512	0.08798	21.56059
81	7.20	0.80000	0.61511	0.61176	0.06405	23.85594
91	9.60	0.90000	0.60501	0.60501	-0.00039	29.86981
101	-12.00	1.00000	0.59661	0.59210	-0.07317	36.87785
111	-9.60	1.10000	0.59669	0.59669	0.00091	29.74583
121	-7.20	1.20000	0.59255	0.58900	0.06475	23.55995
131	-4.80	1.30000	0.54154	0.53989	0.04226	25.35764
141	-2.40	1.40000	0.53839	0.53185	-0.08368	38.77483
151	0.00	1.50000	0.50342	0.50342	0.0	29.83302
161	2.40	1.60000	0.58627	0.57969	0.08761	21.23846
171	4.80	1.70000	0.61148	0.60512	0.08798	21.56059
181	7.20	1.80000	0.61511	0.61176	0.06405	23.85594
191	9.60	1.90000	0.60501	0.60501	-0.00039	29.86981
201	-12.00	2.00000	0.59661	0.59210	-0.07317	36.87785

PERTURBATION VELOCITY PROFILE

I	THETA	S	VPT	VPS	VPN
1	-12.00	0.0	0.11497	0.08868	-0.07317
11	-9.60	0.10000	0.09327	0.09327	0.00091
21	-7.20	0.20000	0.10732	0.08558	0.06475
31	-4.80	0.30000	0.05582	0.03647	0.04226
41	-2.40	0.40000	0.08838	0.02843	-0.08368
51	0.00	0.50000	0.0	0.0	0.0
61	2.40	0.60000	0.11616	0.07627	0.08761

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71	4.80	0.70000	0.13447	0.10169	0.08798
81	7.20	0.80000	0.12586	0.10834	0.06405
91	9.60	0.90000	0.10159	0.10159	-0.00039
101	-12.00	1.00000	0.11497	0.08868	-0.07317
111	-9.60	1.10000	0.09327	0.09327	0.00091
121	-7.20	1.20000	0.10732	0.08558	0.06475
131	-4.80	1.30000	0.05582	0.03647	0.04226
141	-2.40	1.40000	0.08838	0.02843	-0.08368
151	0.00	1.50000	0.0	0.0	0.0
161	2.40	1.60000	0.11616	0.07627	0.08761
171	4.80	1.70000	0.13447	0.10169	0.08798
181	7.20	1.80000	0.12586	0.10834	0.06405
191	9.60	1.90000	0.10159	0.10159	-0.00039
201	-12.00	2.00000	0.11497	0.08868	-0.07317

TURBULENT VELOCITY PROFILE

I	THETA	S	UVTI	WTI
1	-12.00	0.0	0.03328	0.03942
11	-9.60	0.10000	0.03328	0.03942
21	-7.20	0.20000	0.03328	0.03942
31	-4.80	0.30000	0.03328	0.03942
41	-2.40	0.40000	0.03328	0.03942
51	0.00	0.50000	0.03328	0.03942
61	2.40	0.60000	0.03328	0.03942
71	4.80	0.70000	0.03328	0.03942
81	7.20	0.80000	0.03328	0.03942
91	9.60	0.90000	0.03328	0.03942
101	-12.00	1.00000	0.03328	0.03942
111	-9.60	1.10000	0.03328	0.03942
121	-7.20	1.20000	0.03328	0.03942
131	-4.80	1.30000	0.03328	0.03942
141	-2.40	1.40000	0.03328	0.03942
151	0.00	1.50000	0.03328	0.03942
161	2.40	1.60000	0.03328	0.03942
171	4.80	1.70000	0.03328	0.03942
181	7.20	1.80000	0.03328	0.03942
191	9.60	1.90000	0.03328	0.03942
201	-12.00	2.00000	0.03328	0.03942

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HARMONIC CONTENT OF ROTOR WAKE/VORTEX FLOW

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.016016	1.085238	-1.36
2	0.034061	-0.590524	5.19
3	0.014778	1.130787	-2.06
4	0.005910	-1.522206	-10.02
5	0.003886	0.428642	-13.66

DIMENSIONAL QUANTITIES

RADIUS	=	0.81 FT
WHEEL SPEED	=	533.78 FPS
RPM	=	6306.12 RPM
BPF	=	1576.53 HZ

*** STREAMLINE NUMBER 2 ***

CD = 0.1070

LINEAR RATIONAL FUNCTION ROTOR WAKE PROFILE

WFS/UT	=	1.0216
WD/UT	=	0.1772
SDIST	=	0.8431
WAKE WIDTH	=	0.2145
UVT	=	0.0351
WTT	=	0.0418

TIP VORTEX PARAMETERS

CL	=	1.1167
FRL	=	0.2901
AO/S	=	0.0649
A/S	=	0.0880
VSDVO/U	=	0.3863
VSDV/U	=	0.2096
CIRCO/(S*U)	=	0.1410
CIR/(S*U)	=	0.1038
DAO/U	=	0.3460
BN	=	0.4200
BR	=	0.0962

ROTOR WAKE GUST DESCRIPTION FOR CASE 1

RELATIVE VELOCITY PROFILE

I	THETA	S	WT	WS	WN	BETA
1	-12.00	0.0	0.84477	0.84433	0.02721	49.87357
11	-9.60	0.10000	0.92641	0.92590	0.03054	49.91716
21	-7.20	0.20000	0.98956	0.98894	0.03487	50.04695
31	-4.80	0.30000	0.96276	0.96251	0.02185	49.32790
41	-2.40	0.40000	0.84565	0.84368	-0.05760	51.93318
51	0.00	0.50000	0.91777	0.91765	-0.01500	48.96448
61	2.40	0.60000	1.00930	1.00871	0.03460	49.99232
71	4.80	0.70000	1.01294	1.01242	0.03242	49.86165
81	7.20	0.80000	0.99174	0.99134	0.02825	49.65997
91	9.60	0.90000	0.92629	0.92591	0.02643	49.66309
101	-12.00	1.00000	0.84477	0.84433	0.02721	49.87357
111	-9.60	1.10000	0.92641	0.92590	0.03054	49.91716
121	-7.20	1.20000	0.98956	0.98894	0.03487	50.04695
131	-4.80	1.30000	0.96276	0.96251	0.02185	49.32790
141	-2.40	1.40000	0.84565	0.84368	-0.05760	51.93318
151	0.00	1.50000	0.91777	0.91765	-0.01500	48.96448
161	2.40	1.60000	1.00930	1.00871	0.03460	49.99232
171	4.80	1.70000	1.01294	1.01242	0.03242	49.86165
181	7.20	1.80000	0.99174	0.99134	0.02825	49.65997
191	9.60	1.90000	0.92629	0.92591	0.02643	49.66309
201	-12.00	2.00000	0.84477	0.84433	0.02721	49.87357

ABSOLUTE VELOCITY PROFILE

I	THETA	S	VT	VS	VN	ALPHA
1	-12.00	0.0	0.64944	0.64590	-0.06771	33.03795
11	-9.60	0.10000	0.66379	0.66368	0.01197	26.02002
21	-7.20	0.20000	0.67977	0.67573	0.07400	20.80362

31	-4.80	0.30000	0.68300	0.68151	0.04511	23.26657
41	-2.40	0.40000	0.61934	0.61637	-0.06051	32.66023
51	0.00	0.50000	0.67657	0.67657	0.0	27.05345
61	2.40	0.60000	0.68740	0.68108	0.09303	19.27541
71	4.80	0.70000	0.69086	0.68415	0.09606	19.06084
81	7.20	0.80000	0.68681	0.68275	0.07461	20.81670
91	9.60	0.90000	0.66774	0.66765	0.01092	26.11600
101	-12.00	1.00000	0.64944	0.64590	-0.06771	33.03795
111	-9.60	1.10000	0.66379	0.66368	0.01197	26.02002
121	-7.20	1.20000	0.67977	0.67573	0.07400	20.80362
131	-4.80	1.30000	0.68300	0.68151	0.04511	23.26657
141	-2.40	1.40000	0.61934	0.61637	-0.06051	32.66023
151	0.00	1.50000	0.67657	0.67657	0.0	27.05345
161	2.40	1.60000	0.68740	0.68108	0.09303	19.27541
171	4.80	1.70000	0.69086	0.68415	0.09606	19.06084
181	7.20	1.80000	0.68681	0.68275	0.07461	20.81670
191	9.60	1.90000	0.66774	0.66765	0.01092	26.11600
201	-12.00	2.00000	0.64944	0.64590	-0.06771	33.03795

PERTURBATION VELOCITY PROFILE

I	THETA	S	VPT	VPS	VPN
1	-12.00	0.0	0.07433	-0.03067	-0.06771
11	-9.60	0.10000	0.01759	-0.01289	0.01197
21	-7.20	0.20000	0.07401	-0.00084	0.07400
31	-4.80	0.30000	0.04538	0.00494	0.04511
41	-2.40	0.40000	0.08536	-0.06020	-0.06051
51	0.00	0.50000	0.0	0.0	0.0
61	2.40	0.60000	0.09314	0.00451	0.09303
71	4.80	0.70000	0.09636	0.00757	0.09606
81	7.20	0.80000	0.07487	0.00617	0.07461
91	9.60	0.90000	0.01410	-0.00892	0.01092
101	-12.00	1.00000	0.07433	-0.03067	-0.06771
111	-9.60	1.10000	0.01759	-0.01289	0.01197
121	-7.20	1.20000	0.07401	-0.00084	0.07400
131	-4.80	1.30000	0.04538	0.00494	0.04511
141	-2.40	1.40000	0.08536	-0.06020	-0.06051
151	0.00	1.50000	0.0	0.0	0.0
161	2.40	1.60000	0.09314	0.00451	0.09303
171	4.80	1.70000	0.09636	0.00757	0.09606
181	7.20	1.80000	0.07487	0.00617	0.07461
191	9.60	1.90000	0.01410	-0.00892	0.01092
201	-12.00	2.00000	0.07433	-0.03067	-0.06771

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TURBULENT VELOCITY PROFILE

I	THETA	S	UVTI	WTI
1	-12.00	0.0	0.03514	0.04176
11	-9.60	0.10000	0.03514	0.04176
21	-7.20	0.20000	0.03514	0.04176
31	-4.80	0.30000	0.03514	0.04176
41	-2.40	0.40000	0.03514	0.04176
51	0.00	0.50000	0.03514	0.04176
61	2.40	0.60000	0.03514	0.04176
71	4.80	0.70000	0.03514	0.04176
81	7.20	0.80000	0.03514	0.04176
91	9.60	0.90000	0.03514	0.04176
101	-12.00	1.00000	0.03514	0.04176
111	-9.60	1.10000	0.03514	0.04176
121	-7.20	1.20000	0.03514	0.04176
131	-4.80	1.30000	0.03514	0.04176
141	-2.40	1.40000	0.03514	0.04176

151	0.00	1.50000	0.03514	0.04176
161	2.40	1.60000	0.03514	0.04176
171	4.80	1.70000	0.03514	0.04176
181	7.20	1.80000	0.03514	0.04176
191	9.60	1.90000	0.03514	0.04176
201	-12.00	2.00000	0.03514	0.04176

HARMONIC CONTENT OF ROTOR WAKE/VORTEX FLOW

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.015746	1.087363	-1.77
2	0.033299	-0.563040	4.74
3	0.013498	1.019276	-3.11
4	0.004469	-1.219669	-12.71
5	0.002554	0.257714	-17.56

DIMENSIONAL QUANTITIES

RADIUS	=	0.79 FT
WHEEL SPEED	=	518.15 FPS
RPM	=	6296.70 RPM
BPF	=	1574.17 HZ

*** STREAMLINE NUMBER 3 ***

CD = 0.1046

LINEAR RATIONAL FUNCTION ROTOR WAKE PROFILE

WFS/UT	=	1.0450
WD/UT	=	0.1847
SDIST	=	0.8153
WAKE WIDTH	=	0.2095
UVT	=	0.0360
WTT	=	0.0428

TIP VORTEX PARAMETERS

CL	=	1.1167
FRL	=	0.2901
AO/S	=	0.0649
A/S	=	0.0874
VSDVO/U	=	0.3863
VSDV/U	=	0.2128
CIRCO/(S*U)	=	0.1410
CIR/(S*U)	=	0.1046
DAO/U	=	0.3460
BN	=	0.4200
BR	=	0.0957

ROTOR WAKE GUST DESCRIPTION FOR CASE 1

RELATIVE VELOCITY PROFILE

I	THETA	S	WT	WS	WN	BETA
1	-12.00	0.0	0.86061	0.86031	0.02246	47.51683
11	-9.60	0.10000	0.94809	0.94783	0.02213	47.35838
21	-7.20	0.20000	1.01457	1.01443	0.01673	46.96376
31	-4.80	0.30000	1.01671	1.01664	-0.01249	46.72296
41	-2.40	0.40000	0.97544	0.97170	-0.08533	51.03940
51	0.00	0.50000	1.00342	1.00263	-0.03970	48.28745
61	2.40	0.60000	1.03859	1.03854	0.00989	46.56459
71	4.80	0.70000	1.03664	1.03643	0.02112	47.18686
81	7.20	0.80000	1.01558	1.01534	0.02250	47.28960
91	9.60	0.90000	0.94809	0.94783	0.02237	47.37308
101	-12.00	1.00000	0.86061	0.86031	0.02246	47.51683
111	-9.60	1.10000	0.94809	0.94783	0.02213	47.35838
121	-7.20	1.20000	1.01457	1.01443	0.01673	46.96376
131	-4.80	1.30000	1.01671	1.01664	-0.01249	46.72296
141	-2.40	1.40000	0.97544	0.97170	-0.08533	51.03940
151	0.00	1.50000	1.00342	1.00263	-0.03970	48.28745
161	2.40	1.60000	1.03859	1.03854	0.00989	46.56459
171	4.80	1.70000	1.03664	1.03643	0.02112	47.18686
181	7.20	1.80000	1.01558	1.01534	0.02250	47.28960
191	9.60	1.90000	0.94809	0.94783	0.02237	47.37308
201	-12.00	2.00000	0.86061	0.86031	0.02246	47.51683

ABSOLUTE VELOCITY PROFILE

I	THETA	S	VT	VS	VN	ALPHA
1	-12.00	0.0	0.68651	0.67260	-0.13747	32.15076
11	-9.60	0.10000	0.70995	0.70764	-0.05727	25.22633
21	-7.20	0.20000	0.73906	0.73906	0.00171	20.46735
31	-4.80	0.30000	0.74382	0.74382	0.00205	20.44170
41	-2.40	0.40000	0.65918	0.65910	-0.01028	21.49316
51	0.00	0.50000	0.71327	0.71327	0.0	20.59978
61	2.40	0.60000	0.75520	0.75490	0.02113	18.99663
71	4.80	0.70000	0.74412	0.74375	0.02364	18.77905
81	7.20	0.80000	0.73412	0.73410	0.00484	20.22235
91	9.60	0.90000	0.70972	0.70742	-0.05717	25.22017
101	-12.00	1.00000	0.68651	0.67260	-0.13747	32.15076
111	-9.60	1.10000	0.70995	0.70764	-0.05727	25.22633
121	-7.20	1.20000	0.73906	0.73906	0.00171	20.46735
131	-4.80	1.30000	0.74382	0.74382	0.00205	20.44170
141	-2.40	1.40000	0.65918	0.65910	-0.01028	21.49316
151	0.00	1.50000	0.71327	0.71327	0.0	20.59978
161	2.40	1.60000	0.75520	0.75490	0.02113	18.99663
171	4.80	1.70000	0.74412	0.74375	0.02364	18.77905
181	7.20	1.80000	0.73412	0.73410	0.00484	20.22235
191	9.60	1.90000	0.70972	0.70742	-0.05717	25.22017
201	-12.00	2.00000	0.68651	0.67260	-0.13747	32.15076

PERTURBATION VELOCITY PROFILE

I	THETA	S	VPT	VPS	VPN
1	-12.00	0.0	0.14336	-0.04067	-0.13747
11	-9.60	0.10000	0.05754	-0.00563	-0.05727
21	-7.20	0.20000	0.02584	0.02578	0.00171
31	-4.80	0.30000	0.03062	0.03055	0.00205
41	-2.40	0.40000	0.05514	-0.05417	-0.01028
51	0.00	0.50000	0.0	0.0	0.0
61	2.40	0.60000	0.04668	0.04163	0.02113
71	4.80	0.70000	0.03857	0.03047	0.02364
81	7.20	0.80000	0.02138	0.02083	0.00484
91	9.60	0.90000	0.05747	-0.00586	-0.05717
101	-12.00	1.00000	0.14336	-0.04067	-0.13747

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111	-9.60	1.10000	0.05754	-0.00563	-0.05727
121	-7.20	1.20000	0.02584	0.02578	0.00171
131	-4.80	1.30000	0.03062	0.03055	0.00205
141	-2.40	1.40000	0.05514	-0.05417	-0.01028
151	0.00	1.50000	0.0	0.0	0.0
161	2.40	1.60000	0.04668	0.04163	0.02113
171	4.80	1.70000	0.03857	0.03047	0.02364
181	7.20	1.80000	0.02138	0.02083	0.00484
191	9.60	1.90000	0.05747	-0.00586	-0.05717
201	-12.00	2.00000	0.14336	-0.04067	-0.13747

TURBULENT VELOCITY PROFILE

I	THETA	S	UVTI	WTI
1	-12.00	0.0	0.03597	0.04278
11	-9.60	0.10000	0.03597	0.04278
21	-7.20	0.20000	0.03597	0.04278
31	-4.80	0.30000	0.03597	0.04278
41	-2.40	0.40000	0.03597	0.04278
51	0.00	0.50000	0.03597	0.04278
61	2.40	0.60000	0.03597	0.04278
71	4.80	0.70000	0.03597	0.04278
81	7.20	0.80000	0.03597	0.04278
91	9.60	0.90000	0.03597	0.04278
101	-12.00	1.00000	0.03597	0.04278
111	-9.60	1.10000	0.03597	0.04278
121	-7.20	1.20000	0.03597	0.04278
131	-4.80	1.30000	0.03597	0.04278
141	-2.40	1.40000	0.03597	0.04278
151	0.00	1.50000	0.03597	0.04278
161	2.40	1.60000	0.03597	0.04278
171	4.80	1.70000	0.03597	0.04278
181	7.20	1.80000	0.03597	0.04278
191	9.60	1.90000	0.03597	0.04278
201	-12.00	2.00000	0.03597	0.04278

HARMONIC CONTENT OF ROTOR WAKE/VORTEX FLOW

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.024664	0.172117	1.90
2	0.019835	-0.202510	0.01
3	0.008006	0.176590	-7.87
4	0.003658	-0.002205	-14.67
5	0.001570	-0.050478	-22.02

DIMENSIONAL QUANTITIES

RADIUS = 0.76 FT
WHEEL SPEED = 504.75 FPS
RPM = 6314.65 RPM
BPF = 1578.66 HZ

*** STREAMLINE NUMBER 4 ***

CD = 0.0523

LINEAR RATIONAL FUNCTION ROTOR WAKE PROFILE

WFS/UT	=	1.0821
WD/UT	=	0.1611
SDIST	=	0.8136
WAKE WIDTH	=	0.1976
UVT	=	0.0381
WTT	=	0.0461

TIP VORTEX PARAMETERS

CL	=	1.1167
FRL	=	0.2901
A0/S	=	0.0649
A/S	=	0.0873
VSDV0/U	=	0.3863
VSDV/U	=	0.2130
CIRC0/(S*U)	=	0.1410
CIR/(S*U)	=	0.1047
GA0/U	=	0.3460
BN	=	0.4200
BR	=	0.0959

ROTOR WAKE GUST DESCRIPTION FOR CASE 1

RELATIVE VELOCITY PROFILE

I	THETA	S	WT	WS	WN	BETA
1	-12.00	0.0	0.92104	0.92099	0.00942	42.22495
11	-9.60	0.10000	1.00271	1.00269	0.00625	41.99298
21	-7.20	0.20000	1.05982	1.05982	-0.00005	41.63910
31	-4.80	0.30000	1.07621	1.07618	-0.00867	42.09709
41	-2.40	0.40000	1.08051	1.08042	-0.01450	42.40425
51	0.00	0.50000	1.08134	1.08128	-0.01177	42.26216
61	2.40	0.60000	1.08046	1.08045	-0.00339	41.81041
71	4.80	0.70000	1.07620	1.07619	0.00413	41.85490
81	7.20	0.80000	1.05986	1.05982	0.00849	42.09409
91	9.60	0.90000	1.00273	1.00268	0.01009	42.21449
101	-12.00	1.00000	0.92104	0.92099	0.00942	42.22495
111	-9.60	1.10000	1.00271	1.00269	0.00625	41.99298
121	-7.20	1.20000	1.05982	1.05982	-0.00005	41.63910
131	-4.80	1.30000	1.07621	1.07618	-0.00867	42.09709
141	-2.40	1.40000	1.08051	1.08042	-0.01450	42.40425
151	0.00	1.50000	1.08134	1.08128	-0.01177	42.26216
161	2.40	1.60000	1.08046	1.08045	-0.00339	41.81041
171	4.80	1.70000	1.07620	1.07619	0.00413	41.85490
181	7.20	1.80000	1.05986	1.05982	0.00849	42.09409
191	9.60	1.90000	1.00273	1.00268	0.01009	42.21449
201	-12.00	2.00000	0.92104	0.92099	0.00942	42.22495

ABSOLUTE VELOCITY PROFILE

I	THETA	S	VT	VS	VN	ALPHA
1	-12.00	0.0	0.78125	0.76850	-0.14061	29.18985
11	-9.60	0.10000	0.81469	0.81158	-0.07112	23.82956
21	-7.20	0.20000	0.84549	0.84514	-0.02446	20.47948
31	-4.80	0.30000	0.84574	0.84572	-0.00599	19.22760
41	-2.40	0.40000	0.84274	0.84274	0.00057	18.78300
51	0.00	0.50000	0.84548	0.84548	0.0	18.82162
61	2.40	0.60000	0.85251	0.85250	-0.00492	19.15245

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71	4.80	0.70000	0.84972	0.84968	-0.00823	19.37627
81	7.20	0.80000	0.83806	0.83781	-0.02031	20.21051
91	9.60	0.90000	0.81116	0.80820	-0.06921	23.71637
101	-12.00	1.00000	0.78125	0.76850	-0.14061	29.18985
111	-9.60	1.10000	0.81469	0.81158	-0.07112	23.82956
121	-7.20	1.20000	0.84549	0.84514	-0.02446	20.47948
131	-4.80	1.30000	0.84574	0.84572	-0.00599	19.22760
141	-2.40	1.40000	0.84274	0.84274	0.00057	18.78300
151	0.00	1.50000	0.84548	0.84548	0.0	18.82162
161	2.40	1.60000	0.85251	0.85250	-0.00492	19.15245
171	4.80	1.70000	0.84972	0.84968	-0.00823	19.37627
181	7.20	1.80000	0.83806	0.83781	-0.02031	20.21051
191	9.60	1.90000	0.81116	0.80820	-0.06921	23.71637
201	-12.00	2.00000	0.78125	0.76850	-0.14061	29.18985

PERTURBATION VELOCITY PROFILE

I	THETA	S	VPT	VPS	VPN
1	-12.00	0.0	0.16030	-0.07699	-0.14061
11	-9.60	0.10000	0.07879	-0.03390	-0.07112
21	-7.20	0.20000	0.02446	-0.00035	-0.02446
31	-4.80	0.30000	0.00600	0.00023	-0.00599
41	-2.40	0.40000	0.00281	-0.00275	0.00057
51	0.00	0.50000	0.0	0.0	0.0
61	2.40	0.60000	0.00857	0.00701	-0.00492
71	4.80	0.70000	0.00923	0.00420	-0.00823
81	7.20	0.80000	0.02171	-0.00767	-0.02031
91	9.60	0.90000	0.07861	-0.03728	-0.06921
101	-12.00	1.00000	0.16030	-0.07699	-0.14061
111	-9.60	1.10000	0.07879	-0.03390	-0.07112
121	-7.20	1.20000	0.02446	-0.00035	-0.02446
131	-4.80	1.30000	0.00600	0.00023	-0.00599
141	-2.40	1.40000	0.00281	-0.00275	0.00057
151	0.00	1.50000	0.0	0.0	0.0
161	2.40	1.60000	0.00857	0.00701	-0.00492
171	4.80	1.70000	0.00923	0.00420	-0.00823
181	7.20	1.80000	0.02171	-0.00767	-0.02031
191	9.60	1.90000	0.07861	-0.03728	-0.06921
201	-12.00	2.00000	0.16030	-0.07699	-0.14061

TURBULENT VELOCITY PROFILE

I	THETA	S	UVTI	WTI
1	-12.00	0.0	0.03808	0.04614
11	-9.60	0.10000	0.03808	0.04614
21	-7.20	0.20000	0.03808	0.04614
31	-4.80	0.30000	0.03808	0.04614
41	-2.40	0.40000	0.03808	0.04614
51	0.00	0.50000	0.03808	0.04614
61	2.40	0.60000	0.03808	0.04614
71	4.80	0.70000	0.03808	0.04614
81	7.20	0.80000	0.03808	0.04614
91	9.60	0.90000	0.03808	0.04614
101	-12.00	1.00000	0.03808	0.04614
111	-9.60	1.10000	0.03808	0.04614
121	-7.20	1.20000	0.03808	0.04614
131	-4.80	1.30000	0.03808	0.04614
141	-2.40	1.40000	0.03808	0.04614
151	0.00	1.50000	0.03808	0.04614
161	2.40	1.60000	0.03808	0.04614
171	4.80	1.70000	0.03808	0.04614
181	7.20	1.80000	0.03808	0.04614

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191	9.60	1.90000	0.03808	0.04614
201	-12.00	2.00000	0.03808	0.04614

HARMONIC CONTENT OF ROTOR WAKE/VORTEX FLOW

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.025867	-0.004277	1.53
2	0.013638	0.079655	-4.03
3	0.007123	-0.059623	-9.67
4	0.003347	-0.044773	-16.23
5	0.001757	0.051444	-21.83

DIMENSIONAL QUANTITIES

RADIUS	=	0.70 FT
WHEEL SPEED	=	461.20 FPS
RPM	=	6329.51 RPM
BPF	=	1582.38 HZ

*** STREAMLINE NUMBER 5 ***

CD = 0.0366

LINEAR RATIONAL FUNCTION ROTOR WAKE PROFILE

WFS/UT	=	1.1115
WD/UT	=	0.1471
SDIST	=	0.8460
WAKE WIDTH	=	0.1968
UVT	=	0.0399
WTT	=	0.0492

TIP VORTEX PARAMETERS

CL	=	1.1167
FRL	=	0.2901
AO/S	=	0.0649
A/S	=	0.0881
VSDVO/U	=	0.3863
VSDV/U	=	0.2093
CIRCO/(S*U)	=	0.1410
CIR/(S*U)	=	0.1038
DAO/U	=	0.3460
BN	=	0.4200
BR	=	0.0971

ROTOR WAKE GUST DESCRIPTION FOR CASE 1

RELATIVE VELOCITY PROFILE

I	THETA	S	WT	WS	WN	BETA
1	-12.00	0.0	0.96432	0.96432	0.00228	36.30927
11	-9.60	0.10000	1.03923	1.03923	0.00119	36.17221
21	-7.20	0.20000	1.09130	1.09130	-0.00041	36.17221

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31	-4.80	0.30000	1.10612	1.10612	-0.00194	36.24883
41	-2.40	0.40000	1.10997	1.10997	-0.00273	36.30344
51	0.00	0.50000	1.11073	1.11073	-0.00238	36.27875
61	2.40	0.60000	1.10997	1.10997	-0.00107	36.17221
71	4.80	0.70000	1.10612	1.10612	0.00058	36.17221
81	7.20	0.80000	1.09130	1.09130	0.00193	36.24883
91	9.60	0.90000	1.03923	1.03923	0.00255	36.30783
101	-12.00	1.00000	0.96432	0.96432	0.00228	36.30927
111	-9.60	1.10000	1.03923	1.03923	0.00119	36.17221
121	-7.20	1.20000	1.09130	1.09130	-0.00041	36.17221
131	-4.80	1.30000	1.10612	1.10612	-0.00194	36.24883
141	-2.40	1.40000	1.10997	1.10997	-0.00273	36.30344
151	0.00	1.50000	1.11073	1.11073	-0.00238	36.27875
161	2.40	1.60000	1.10997	1.10997	-0.00107	36.17221
171	4.80	1.70000	1.10612	1.10612	0.00058	36.17221
181	7.20	1.80000	1.09130	1.09130	0.00193	36.24883
191	9.60	1.90000	1.03923	1.03923	0.00255	36.30783
201	-12.00	2.00000	0.96432	0.96432	0.00228	36.30927

ABSOLUTE VELOCITY PROFILE

I	THETA	S	VT	VS	VN	ALPHA
1	-12.00	0.0	0.88763	0.87909	-0.12282	28.90047
11	-9.60	0.10000	0.92372	0.92170	-0.06116	24.74344
21	-7.20	0.20000	0.95012	0.94996	-0.01744	21.99864
31	-4.80	0.30000	0.95678	0.95677	-0.00418	21.19753
41	-2.40	0.40000	0.95796	0.95796	-0.00038	20.96951
51	0.00	0.50000	0.95878	0.95878	0.0	20.94691
61	2.40	0.60000	0.96010	0.96010	-0.00176	21.05182
71	4.80	0.70000	0.95802	0.95801	-0.00499	21.24529
81	7.20	0.80000	0.94888	0.94874	-0.01665	21.95227
91	9.60	0.90000	0.92157	0.91963	-0.05983	24.66946
101	-12.00	1.00000	0.88763	0.87909	-0.12282	28.90047
111	-9.60	1.10000	0.92372	0.92170	-0.06116	24.74344
121	-7.20	1.20000	0.95012	0.94996	-0.01744	21.99864
131	-4.80	1.30000	0.95678	0.95677	-0.00418	21.19753
141	-2.40	1.40000	0.95796	0.95796	-0.00038	20.96951
151	0.00	1.50000	0.95878	0.95878	0.0	20.94691
161	2.40	1.60000	0.96010	0.96010	-0.00176	21.05182
171	4.80	1.70000	0.95802	0.95801	-0.00499	21.24529
181	7.20	1.80000	0.94888	0.94874	-0.01665	21.95227
191	9.60	1.90000	0.92157	0.91963	-0.05983	24.66946
201	-12.00	2.00000	0.88763	0.87909	-0.12282	28.90047

PERTURBATION VELOCITY PROFILE

I	THETA	S	VPT	VPS	VPN
1	-12.00	0.0	0.14641	-0.07969	-0.12282
11	-9.60	0.10000	0.07152	-0.03708	-0.06116
21	-7.20	0.20000	0.01954	-0.00881	-0.01744
31	-4.80	0.30000	0.00464	-0.00201	-0.00418
41	-2.40	0.40000	0.00090	-0.00081	-0.00038
51	0.00	0.50000	0.0	0.0	0.0
61	2.40	0.60000	0.00220	0.00132	-0.00176
71	4.80	0.70000	0.00505	-0.00077	-0.00499
81	7.20	0.80000	0.01944	-0.01004	-0.01665
91	9.60	0.90000	0.07150	-0.03915	-0.05983
101	-12.00	1.00000	0.14641	-0.07969	-0.12282
111	-9.60	1.10000	0.07152	-0.03708	-0.06116
121	-7.20	1.20000	0.01954	-0.00881	-0.01744
131	-4.80	1.30000	0.00464	-0.00201	-0.00418
141	-2.40	1.40000	0.00090	-0.00081	-0.00038

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151	0.00	1.50000	0.0	0.0	0.0
161	2.40	1.60000	0.00220	0.00132	-0.00176
171	4.80	1.70000	0.00505	-0.00077	-0.00499
181	7.20	1.80000	0.01944	-0.01004	-0.01665
191	9.60	1.90000	0.07150	-0.03915	-0.05983
201	-12.00	2.00000	0.14641	-0.07969	-0.12282

TURBULENT VELOCITY PROFILE

I	THETA	S	UVTI	WTI
1	-12.00	0.0	0.03995	0.04923
11	-9.60	0.10000	0.03995	0.04923
21	-7.20	0.20000	0.03995	0.04923
31	-4.80	0.30000	0.03995	0.04923
41	-2.40	0.40000	0.03995	0.04923
51	0.00	0.50000	0.03995	0.04923
61	2.40	0.60000	0.03995	0.04923
71	4.80	0.70000	0.03995	0.04923
81	7.20	0.80000	0.03995	0.04923
91	9.60	0.90000	0.03995	0.04923
101	-12.00	1.00000	0.03995	0.04923
111	-9.60	1.10000	0.03995	0.04923
121	-7.20	1.20000	0.03995	0.04923
131	-4.80	1.30000	0.03995	0.04923
141	-2.40	1.40000	0.03995	0.04923
151	0.00	1.50000	0.03995	0.04923
161	2.40	1.60000	0.03995	0.04923
171	4.80	1.70000	0.03995	0.04923
181	7.20	1.80000	0.03995	0.04923
191	9.60	1.90000	0.03995	0.04923
201	-12.00	2.00000	0.03995	0.04923

HARMONIC CONTENT OF ROTOR WAKE/VORTEX FLOW

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.022583	0.000033	-0.84
2	0.012397	0.025601	-6.05
3	0.006266	-0.002458	-11.97
4	0.003005	-0.016467	-18.36
5	0.001438	0.003199	-24.76

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DIMENSIONAL QUANTITIES

RADIUS	=	0.61 FT
WHEEL SPEED	=	402.01 FPS
RPM	=	6328.16 RPM
BPF	=	1582.04 HZ

*** STREAMLINE NUMBER 6 ***

CD = 0.0241

LINEAR RATIONAL FUNCTION ROTOR WAKE PROFILE

WFS/UT	=	1.1754
WD/UT	=	0.1345
SDIST	=	0.8946

WAKE WIDTH = 0.1973
UVT = 0.0440
WTT = 0.0558

TIP VORTEX PARAMETERS

CL	1.1167
FRL	0.2901
AO/S	0.0649
A/S	0.0893
VSDVO/U	0.3863
VSDV/U	0.2039
CIRCO/(S*U)	0.1410
CIR/(S*U)	0.1024
GAO/U	0.3460
BN	0.4200
BR	0.0988

ROTOR WAKE GUST DESCRIPTION FOR CASE 1

RELATIVE VELOCITY PROFILE

I	THETA	S	WT	WS	WN	BETA
1	-12.00	0.0	1.04087	1.04087	0.00051	29.84811
11	-9.60	0.10000	1.10919	1.10919	0.00025	29.84811
21	-7.20	0.20000	1.15685	1.15685	-0.00011	29.84811
31	-4.80	0.30000	1.17048	1.17048	-0.00043	29.84811
41	-2.40	0.40000	1.17402	1.17402	-0.00059	29.84811
51	0.00	0.50000	1.17472	1.17472	-0.00052	29.84811
61	2.40	0.60000	1.17402	1.17402	-0.00025	29.84811
71	4.80	0.70000	1.17048	1.17048	0.00011	29.84811
81	7.20	0.80000	1.15685	1.15685	0.00043	29.84811
91	9.60	0.90000	1.10918	1.10918	0.00058	29.84811
101	-12.00	1.00000	1.04087	1.04087	0.00051	29.84811
111	-9.60	1.10000	1.10919	1.10919	0.00025	29.84811
121	-7.20	1.20000	1.15685	1.15685	-0.00011	29.84811
131	-4.80	1.30000	1.17048	1.17048	-0.00043	29.84811
141	-2.40	1.40000	1.17402	1.17402	-0.00059	29.84811
151	0.00	1.50000	1.17472	1.17472	-0.00052	29.84811
161	2.40	1.60000	1.17402	1.17402	-0.00025	29.84811
171	4.80	1.70000	1.17048	1.17048	0.00011	29.84811
181	7.20	1.80000	1.15685	1.15685	0.00043	29.84811
191	9.60	1.90000	1.10918	1.10918	0.00058	29.84811
201	-12.00	2.00000	1.04087	1.04087	0.00051	29.84811

ABSOLUTE VELOCITY PROFILE

I	THETA	S	VT	VS	VN	ALPHA
1	-12.00	0.0	1.02339	1.01793	-0.10551	28.09529
11	-9.60	0.10000	1.06123	1.05997	-0.05166	24.96770
21	-7.20	0.20000	1.08939	1.08930	-0.01408	22.91835
31	-4.80	0.30000	1.09769	1.09768	-0.00335	22.35226
41	-2.40	0.40000	1.09986	1.09986	-0.00055	22.20636
51	0.00	0.50000	1.10029	1.10029	0.0	22.17763
61	2.40	0.60000	1.09986	1.09986	-0.00055	22.20636
71	4.80	0.70000	1.09769	1.09768	-0.00335	22.35226
81	7.20	0.80000	1.08939	1.08930	-0.01409	22.91849
91	9.60	0.90000	1.06122	1.05997	-0.05166	24.96800
101	-12.00	1.00000	1.02339	1.01793	-0.10551	28.09529

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111	-9.60	1.10000	1.06123	1.05997	-0.05166	24.96770
121	-7.20	1.20000	1.08939	1.08930	-0.01408	22.91835
131	-4.80	1.30000	1.09769	1.09768	-0.00335	22.35226
141	-2.40	1.40000	1.09986	1.09986	-0.00055	22.20636
151	0.00	1.50000	1.10029	1.10029	0.0	22.17763
161	2.40	1.60000	1.09986	1.09986	-0.00055	22.20636
171	4.80	1.70000	1.09769	1.09768	-0.00335	22.35226
181	7.20	1.80000	1.08939	1.08930	-0.01409	22.91849
191	9.60	1.90000	1.06122	1.05997	-0.05166	24.96800
201	-12.00	2.00000	1.02339	1.01793	-0.10551	28.09529

PERTURBATION VELOCITY PROFILE

I	THETA	S	VPT	VPS	VPN
1	-12.00	0.0	0.13385	-0.08236	-0.10551
11	-9.60	0.10000	0.06553	-0.04032	-0.05166
21	-7.20	0.20000	0.01787	-0.01099	-0.01408
31	-4.80	0.30000	0.00425	-0.00261	-0.00335
41	-2.40	0.40000	0.00070	-0.00043	-0.00055
51	0.00	0.50000	0.0	0.0	0.0
61	2.40	0.60000	0.00070	-0.00043	-0.00055
71	4.80	0.70000	0.00425	-0.00261	-0.00335
81	7.20	0.80000	0.01787	-0.01099	-0.01409
91	9.60	0.90000	0.06554	-0.04033	-0.05166
101	-12.00	1.00000	0.13385	-0.08236	-0.10551
111	-9.60	1.10000	0.06553	-0.04032	-0.05166
121	-7.20	1.20000	0.01787	-0.01099	-0.01408
131	-4.80	1.30000	0.00425	-0.00261	-0.00335
141	-2.40	1.40000	0.00070	-0.00043	-0.00055
151	0.00	1.50000	0.0	0.0	0.0
161	2.40	1.60000	0.00070	-0.00043	-0.00055
171	4.80	1.70000	0.00425	-0.00261	-0.00335
181	7.20	1.80000	0.01787	-0.01099	-0.01409
191	9.60	1.90000	0.06554	-0.04033	-0.05166
201	-12.00	2.00000	0.13385	-0.08236	-0.10551

TURBULENT VELOCITY PROFILE

I	THETA	S	UVTI	WTI
1	-12.00	0.0	0.04397	0.05584
11	-9.60	0.10000	0.04397	0.05584
21	-7.20	0.20000	0.04397	0.05584
31	-4.80	0.30000	0.04397	0.05584
41	-2.40	0.40000	0.04397	0.05584
51	0.00	0.50000	0.04397	0.05584
61	2.40	0.60000	0.04397	0.05584
71	4.80	0.70000	0.04397	0.05584
81	7.20	0.80000	0.04397	0.05584
91	9.60	0.90000	0.04397	0.05584
101	-12.00	1.00000	0.04397	0.05584
111	-9.60	1.10000	0.04397	0.05584
121	-7.20	1.20000	0.04397	0.05584
131	-4.80	1.30000	0.04397	0.05584
141	-2.40	1.40000	0.04397	0.05584
151	0.00	1.50000	0.04397	0.05584
161	2.40	1.60000	0.04397	0.05584
171	4.80	1.70000	0.04397	0.05584
181	7.20	1.80000	0.04397	0.05584
191	9.60	1.90000	0.04397	0.05584
201	-12.00	2.00000	0.04397	0.05584

HARMONIC CONTENT OF ROTOR WAKE/VORTEX FLOW

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.019405	-0.000025	-3.51
2	0.010816	-0.000059	-8.59
3	0.005369	-0.000095	-14.67
4	0.002587	-0.000115	-21.02
5	0.001238	-0.000142	-27.42

DIMENSIONAL QUANTITIES

RADIUS	=	0.52 FT
WHEEL SPEED	=	343.94 FPS
RPM	=	6357.20 RPM
BPF	=	1589.30 HZ

*** STREAMLINE NUMBER 7 ***

CD = 0.1039

LINEAR RATIONAL FUNCTION ROTOR WAKE PROFILE

WFS/UT	=	1.1931
WD/UT	=	0.1873
SDIST	=	0.9574
WAKE WIDTH	=	0.2329
UVT	=	0.0410
WTT	=	0.0487

TIP VORTEX PARAMETERS

CL	=	1.1167
FRL	=	0.2901
AO/S	=	0.0649
A/S	=	0.0907
VSDVO/U	=	0.3863
VSDV/U	=	0.1974
CIRCO/(S*U)	=	0.1410
CIR/(S*U)	=	0.1008
DAO/U	=	0.3460
BN	=	0.4200
BR	=	0.1009

ROTOR WAKE GUST DESCRIPTION FOR CASE 1

RELATIVE VELOCITY PROFILE

I	THETA	S	WT	WS	WN	BETA
1	-12.00	0.0	1.00574	1.00574	0.00017	25.65283
11	-9.60	0.10000	1.08355	1.08355	0.00008	25.65283
21	-7.20	0.20000	1.15442	1.15442	-0.00004	25.65283
31	-4.80	0.30000	1.18036	1.18036	-0.00014	25.65283
41	-2.40	0.40000	1.18858	1.18858	-0.00020	25.65283
51	0.00	0.50000	1.19045	1.19045	-0.00017	25.65283
61	2.40	0.60000	1.18858	1.18858	-0.00008	25.65283

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71	4.80	0.70000	1.18035	1.18035	0.00004	25.65283
81	7.20	0.80000	1.15442	1.15442	0.00014	25.65283
91	9.60	0.90000	1.08354	1.08354	0.00020	25.65283
101	-12.00	1.00000	1.00574	1.00574	0.00017	25.65283
111	-9.60	1.10000	1.08355	1.08355	0.00008	25.65283
121	-7.20	1.20000	1.15442	1.15442	-0.00004	25.65283
131	-4.80	1.30000	1.18036	1.18036	-0.00014	25.65283
141	-2.40	1.40000	1.18858	1.18858	-0.00020	25.65283
151	0.00	1.50000	1.19045	1.19045	-0.00017	25.65283
161	2.40	1.60000	1.18858	1.18858	-0.00008	25.65283
171	4.80	1.70000	1.18035	1.18035	0.00004	25.65283
181	7.20	1.80000	1.15442	1.15442	0.00014	25.65283
191	9.60	1.90000	1.08354	1.08354	0.00020	25.65283
201	-12.00	2.00000	1.00574	1.00574	0.00017	25.65283

ABSOLUTE VELOCITY PROFILE

I	THETA	S	VT	VS	VN	ALPHA
1	-12.00	0.0	1.06804	1.05863	-0.14141	31.91315
11	-9.60	0.10000	1.11171	1.10870	-0.08184	28.52625
21	-7.20	0.20000	1.15462	1.15429	-0.02758	25.67337
31	-4.80	0.30000	1.17100	1.17098	-0.00773	24.68277
41	-2.40	0.40000	1.17627	1.17627	-0.00143	24.37418
51	0.00	0.50000	1.17747	1.17747	0.0	24.30470
61	2.40	0.60000	1.17627	1.17627	-0.00143	24.37418
71	4.80	0.70000	1.17100	1.17098	-0.00773	24.68288
81	7.20	0.80000	1.15462	1.15429	-0.02758	25.67349
91	9.60	0.90000	1.11171	1.10869	-0.08184	28.52663
101	-12.00	1.00000	1.06804	1.05863	-0.14141	31.91315
111	-9.60	1.10000	1.11171	1.10870	-0.08184	28.52625
121	-7.20	1.20000	1.15462	1.15429	-0.02758	25.67337
131	-4.80	1.30000	1.17100	1.17098	-0.00773	24.68277
141	-2.40	1.40000	1.17627	1.17627	-0.00143	24.37418
151	0.00	1.50000	1.17747	1.17747	0.0	24.30470
161	2.40	1.60000	1.17627	1.17627	-0.00143	24.37418
171	4.80	1.70000	1.17100	1.17098	-0.00773	24.68288
181	7.20	1.80000	1.15462	1.15429	-0.02758	25.67349
191	9.60	1.90000	1.11171	1.10869	-0.08184	28.52663
201	-12.00	2.00000	1.06804	1.05863	-0.14141	31.91315

PERTURBATION VELOCITY PROFILE

I	THETA	S	VPT	VPS	VPN
1	-12.00	0.0	0.18471	-0.11884	-0.14141
11	-9.60	0.10000	0.10690	-0.06877	-0.08184
21	-7.20	0.20000	0.03602	-0.02318	-0.02758
31	-4.80	0.30000	0.01009	-0.00649	-0.00773
41	-2.40	0.40000	0.00186	-0.00120	-0.00143
51	0.00	0.50000	0.0	0.0	0.0
61	2.40	0.60000	0.00186	-0.00120	-0.00143
71	4.80	0.70000	0.01009	-0.00649	-0.00773
81	7.20	0.80000	0.03603	-0.02318	-0.02758
91	9.60	0.90000	0.10691	-0.06878	-0.08184
101	-12.00	1.00000	0.18471	-0.11884	-0.14141
111	-9.60	1.10000	0.10690	-0.06877	-0.08184
121	-7.20	1.20000	0.03602	-0.02318	-0.02758
131	-4.80	1.30000	0.01009	-0.00649	-0.00773
141	-2.40	1.40000	0.00186	-0.00120	-0.00143
151	0.00	1.50000	0.0	0.0	0.0
161	2.40	1.60000	0.00186	-0.00120	-0.00143
171	4.80	1.70000	0.01009	-0.00649	-0.00773
181	7.20	1.80000	0.03603	-0.02318	-0.02758

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191	9.60	1.90000	0.10691	-0.06878	-0.08184
201	-12.00	2.00000	0.18471	-0.11884	-0.14141

TURBULENT VELOCITY PROFILE

I	THETA	S	UVTI	WTI
1	-12.00	0.0	0.04100	0.04868
11	-9.60	0.10000	0.04100	0.04868
21	-7.20	0.20000	0.04100	0.04868
31	-4.80	0.30000	0.04100	0.04868
41	-2.40	0.40000	0.04100	0.04868
51	0.00	0.50000	0.04100	0.04868
61	2.40	0.60000	0.04100	0.04868
71	4.80	0.70000	0.04100	0.04868
81	7.20	0.80000	0.04100	0.04868
91	9.60	0.90000	0.04100	0.04868
101	-12.00	1.00000	0.04100	0.04868
111	-9.60	1.10000	0.04100	0.04868
121	-7.20	1.20000	0.04100	0.04868
131	-4.80	1.30000	0.04100	0.04868
141	-2.40	1.40000	0.04100	0.04868
151	0.00	1.50000	0.04100	0.04868
161	2.40	1.60000	0.04100	0.04868
171	4.80	1.70000	0.04100	0.04868
181	7.20	1.80000	0.04100	0.04868
191	9.60	1.90000	0.04100	0.04868
201	-12.00	2.00000	0.04100	0.04868

HARMONIC CONTENT OF ROTOR WAKE/VORTEX FLOW

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.028343	-0.000026	-1.53
2	0.013498	-0.000060	-7.97
3	0.005781	-0.000078	-15.34
4	0.002426	-0.000090	-22.88
5	0.001014	-0.000138	-30.45

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DIMENSIONAL QUANTITIES

RADIUS	=	0.45 FT
WHEEL SPEED	=	295.93 FPS
RPM	=	6291.63 RPM
BPF	=	1572.91 HZ

*** STREAMLINE NUMBER 8 ***

CD = 0.1551

LINEAR RATIONAL FUNCTION ROTOR WAKE PROFILE

WFS/UT	=	1.1946
WD/UT	=	0.2034
SDIST	=	0.9827
WAKE WIDTH	=	0.2450
UVT	=	0.0408
WTT	=	0.0483

TIP VORTEX PARAMETERS

CL	=	1.1167
FRL	=	0.2901
AO/S	=	0.0649
A/S	=	0.0913
VSDVO/U	=	0.3863
VSDV/U	=	0.1948
CIRCO/(S*U)	=	0.1410
CIR/(S*U)	=	0.1001
OAO/U	=	0.3460
BN	=	0.4200
BR	=	0.1017

ROTOR WAKE GUST DESCRIPTION FOR CASE 1

RELATIVE VELOCITY PROFILE

I	THETA	S	WT	WS	WN	BETA
1	-12.00	0.0	0.99117	0.99117	0.00012	24.50633
11	-9.60	0.10000	1.07020	1.07020	0.00006	24.50633
21	-7.20	0.20000	1.14775	1.14775	-0.00003	24.50633
31	-4.80	0.30000	1.17821	1.17821	-0.00010	24.50633
41	-2.40	0.40000	1.18842	1.18842	-0.00014	24.50633
51	0.00	0.50000	1.19081	1.19081	-0.00012	24.50633
61	2.40	0.60000	1.18842	1.18842	-0.00006	24.50633
71	4.80	0.70000	1.17821	1.17821	0.00003	24.50633
81	7.20	0.80000	1.14775	1.14775	0.00010	24.50633
91	9.60	0.90000	1.07020	1.07020	0.00013	24.50633
101	-12.00	1.00000	0.99117	0.99117	0.00012	24.50633
111	-9.60	1.10000	1.07020	1.07020	0.00006	24.50633
121	-7.20	1.20000	1.14775	1.14775	-0.00003	24.50633
131	-4.80	1.30000	1.17821	1.17821	-0.00010	24.50633
141	-2.40	1.40000	1.18842	1.18842	-0.00014	24.50633
151	0.00	1.50000	1.19081	1.19081	-0.00012	24.50633
161	2.40	1.60000	1.18842	1.18842	-0.00006	24.50633
171	4.80	1.70000	1.17821	1.17821	0.00003	24.50633
181	7.20	1.80000	1.14775	1.14775	0.00010	24.50633
191	9.60	1.90000	1.07020	1.07020	0.00013	24.50633
201	-12.00	2.00000	0.99117	0.99117	0.00012	24.50633

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ABSOLUTE VELOCITY PROFILE

I	THETA	S	VT	VS	VN	ALPHA
1	-12.00	0.0	1.07710	1.06634	-0.15190	33.14195
11	-9.60	0.10000	1.12139	1.11762	-0.09176	29.72853
21	-7.20	0.20000	1.16841	1.16795	-0.03276	26.64130
31	-4.80	0.30000	1.18775	1.18771	-0.00958	25.49702
41	-2.40	0.40000	1.19433	1.19433	-0.00182	25.12199
51	0.00	0.50000	1.19589	1.19589	0.0	25.03468
61	2.40	0.60000	1.19433	1.19433	-0.00182	25.12199
71	4.80	0.70000	1.18775	1.18771	-0.00958	25.49704
81	7.20	0.80000	1.16841	1.16795	-0.03276	26.64140
91	9.60	0.90000	1.12138	1.11762	-0.09177	29.72891
101	-12.00	1.00000	1.07710	1.06634	-0.15190	33.14195
111	-9.60	1.10000	1.12139	1.11762	-0.09176	29.72853
121	-7.20	1.20000	1.16841	1.16795	-0.03276	26.64130
131	-4.80	1.30000	1.18775	1.18771	-0.00958	25.49702
141	-2.40	1.40000	1.19433	1.19433	-0.00182	25.12199

151	0.00	1.50000	1.19589	1.19589	0.0	25.03468
161	2.40	1.60000	1.19433	1.19433	-0.00182	25.12199
171	4.80	1.70000	1.18775	1.18771	-0.00958	25.49704
181	7.20	1.80000	1.16841	1.16795	-0.03276	26.64140
191	9.60	1.90000	1.12138	1.11762	-0.09177	29.72891
201	-12.00	2.00000	1.07710	1.06634	-0.15190	33.14195

PERTURBATION VELOCITY PROFILE

I	THETA	S	VPT	VPS	VPN
1	-12.00	0.0	0.19964	-0.12955	-0.15190
11	-9.60	0.10000	0.12061	-0.07826	-0.09176
21	-7.20	0.20000	0.04305	-0.02794	-0.03276
31	-4.80	0.30000	0.01260	-0.00817	-0.00958
41	-2.40	0.40000	0.00239	-0.00155	-0.00182
51	0.00	0.50000	0.0	0.0	0.0
61	2.40	0.60000	0.00239	-0.00155	-0.00182
71	4.80	0.70000	0.01260	-0.00818	-0.00958
81	7.20	0.80000	0.04306	-0.02794	-0.03276
91	9.60	0.90000	0.12061	-0.07827	-0.09177
101	-12.00	1.00000	0.19964	-0.12955	-0.15190
111	-9.60	1.10000	0.12061	-0.07826	-0.09176
121	-7.20	1.20000	0.04305	-0.02794	-0.03276
131	-4.80	1.30000	0.01260	-0.00817	-0.00958
141	-2.40	1.40000	0.00239	-0.00155	-0.00182
151	0.00	1.50000	0.0	0.0	0.0
161	2.40	1.60000	0.00239	-0.00155	-0.00182
171	4.80	1.70000	0.01260	-0.00818	-0.00958
181	7.20	1.80000	0.04306	-0.02794	-0.03276
191	9.60	1.90000	0.12061	-0.07827	-0.09177
201	-12.00	2.00000	0.19964	-0.12955	-0.15190

TURBULENT VELOCITY PROFILE

I	THETA	S	UVTI	WTI
1	-12.00	0.0	0.04085	0.04830
11	-9.60	0.10000	0.04085	0.04830
21	-7.20	0.20000	0.04085	0.04830
31	-4.80	0.30000	0.04085	0.04830
41	-2.40	0.40000	0.04085	0.04830
51	0.00	0.50000	0.04085	0.04830
61	2.40	0.60000	0.04085	0.04830
71	4.80	0.70000	0.04085	0.04830
81	7.20	0.80000	0.04085	0.04830
91	9.60	0.90000	0.04085	0.04830
101	-12.00	1.00000	0.04085	0.04830
111	-9.60	1.10000	0.04085	0.04830
121	-7.20	1.20000	0.04085	0.04830
131	-4.80	1.30000	0.04085	0.04830
141	-2.40	1.40000	0.04085	0.04830
151	0.00	1.50000	0.04085	0.04830
161	2.40	1.60000	0.04085	0.04830
171	4.80	1.70000	0.04085	0.04830
181	7.20	1.80000	0.04085	0.04830
191	9.60	1.90000	0.04085	0.04830
201	-12.00	2.00000	0.04085	0.04830

HARMONIC CONTENT OF ROTOR WAKE/VORTEX FLOW

NH	MODULUS	PHASE	20*LOG(MODULUS), DB

1	0.031149	-0.000026	-1.11
2	0.014063	-0.000059	-8.02
3	0.005734	-0.000085	-15.81
4	0.002298	-0.000060	-23.75
5	0.000918	-0.000129	-31.72

DIMENSIONAL QUANTITIES

RADIUS	=	0.43 FT
WHEEL SPEED	=	282.52 FPS
RPM	=	6323.49 RPM
BPF	=	1580.87 HZ

*** STREAMLINE NUMBER 9 ***

CD = 0.1288

LINEAR RATIONAL FUNCTION ROTOR WAKE PROFILE

WFS/UT	=	1.2392
WD/UT	=	0.1995
SDIST	=	0.9959
WAKE WIDTH	=	0.2434
UVT	=	0.0424
WTT	=	0.0503

TIP VORTEX PARAMETERS

CL	=	1.1167
FRL	=	0.2901
AO/S	=	0.0649
A/S	=	0.0916
VSDVO/U	=	0.3863
VSDV/U	=	0.1936
CIRCO/(S*U)	=	0.1410
CIR/(S*U)	=	0.0998
DAO/U	=	0.3460
BN	=	0.4200
BR	=	0.1023

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ROTOR WAKE GUST DESCRIPTION FOR CASE 1

RELATIVE VELOCITY PROFILE

I	THETA	S	WT	WS	WN	BETA
1	-12.00	0.0	1.03967	1.03967	0.00008	21.34346
11	-9.60	0.10000	1.11787	1.11787	0.00004	21.34346
21	-7.20	0.20000	1.19387	1.19387	-0.00002	21.34346
31	-4.80	0.30000	1.22345	1.22345	-0.00007	21.34346
41	-2.40	0.40000	1.23330	1.23330	-0.00009	21.34346
51	0.00	0.50000	1.23559	1.23559	-0.00008	21.34346
61	2.40	0.60000	1.23330	1.23330	-0.00004	21.34346
71	4.80	0.70000	1.22345	1.22345	0.00002	21.34346
81	7.20	0.80000	1.19387	1.19387	0.00007	21.34346
91	9.60	0.90000	1.11786	1.11786	0.00009	21.34346
101	-12.00	1.00000	1.03967	1.03967	0.00008	21.34346

111	-9.60	1.10000	1.11787	1.11787	0.00004	21.34346
121	-7.20	1.20000	1.19387	1.19387	-0.00002	21.34346
131	-4.80	1.30000	1.22345	1.22345	-0.00007	21.34346
141	-2.40	1.40000	1.23330	1.23330	-0.00009	21.34346
151	0.00	1.50000	1.23559	1.23559	-0.00008	21.34346
161	2.40	1.60000	1.23330	1.23330	-0.00004	21.34346
171	4.80	1.70000	1.22345	1.22345	0.00002	21.34346
181	7.20	1.80000	1.19387	1.19387	0.00007	21.34346
191	9.60	1.90000	1.11786	1.11786	0.00009	21.34346
201	-12.00	2.00000	1.03967	1.03967	0.00008	21.34346

ABSOLUTE VELOCITY PROFILE

I	THETA	S	VT	VS	VN	ALPHA
1	-12.00	0.0	1.15070	1.14177	-0.14306	32.69702
11	-9.60	0.10000	1.19829	1.19521	-0.08596	29.66899
21	-7.20	0.20000	1.24751	1.24714	-0.03046	26.95464
31	-4.80	0.30000	1.26739	1.26735	-0.00886	25.95615
41	-2.40	0.40000	1.27408	1.27408	-0.00168	25.63086
51	0.00	0.50000	1.27565	1.27565	0.0	25.55542
61	2.40	0.60000	1.27408	1.27408	-0.00168	25.63086
71	4.80	0.70000	1.26739	1.26735	-0.00887	25.95624
81	7.20	0.80000	1.24751	1.24714	-0.03046	26.95476
91	9.60	0.90000	1.19829	1.19520	-0.08596	29.66933
101	-12.00	1.00000	1.15070	1.14177	-0.14306	32.69702
111	-9.60	1.10000	1.19829	1.19521	-0.08596	29.66899
121	-7.20	1.20000	1.24751	1.24714	-0.03046	26.95464
131	-4.80	1.30000	1.26739	1.26735	-0.00886	25.95615
141	-2.40	1.40000	1.27408	1.27408	-0.00168	25.63086
151	0.00	1.50000	1.27565	1.27565	0.0	25.55542
161	2.40	1.60000	1.27408	1.27408	-0.00168	25.63086
171	4.80	1.70000	1.26739	1.26735	-0.00887	25.95624
181	7.20	1.80000	1.24751	1.24714	-0.03046	26.95476
191	9.60	1.90000	1.19829	1.19520	-0.08596	29.66933
201	-12.00	2.00000	1.15070	1.14177	-0.14306	32.69702

PERTURBATION VELOCITY PROFILE

I	THETA	S	VPT	VPS	VPN
1	-12.00	0.0	0.19593	-0.13388	-0.14306
11	-9.60	0.10000	0.11773	-0.08044	-0.08596
21	-7.20	0.20000	0.04172	-0.02851	-0.03046
31	-4.80	0.30000	0.01214	-0.00830	-0.00886
41	-2.40	0.40000	0.00230	-0.00157	-0.00168
51	0.00	0.50000	0.0	0.0	0.0
61	2.40	0.60000	0.00230	-0.00157	-0.00168
71	4.80	0.70000	0.01214	-0.00830	-0.00887
81	7.20	0.80000	0.04172	-0.02851	-0.03046
91	9.60	0.90000	0.11774	-0.08045	-0.08596
101	-12.00	1.00000	0.19593	-0.13388	-0.14306
111	-9.60	1.10000	0.11773	-0.08044	-0.08596
121	-7.20	1.20000	0.04172	-0.02851	-0.03046
131	-4.80	1.30000	0.01214	-0.00830	-0.00886
141	-2.40	1.40000	0.00230	-0.00157	-0.00168
151	0.00	1.50000	0.0	0.0	0.0
161	2.40	1.60000	0.00230	-0.00157	-0.00168
171	4.80	1.70000	0.01214	-0.00830	-0.00887
181	7.20	1.80000	0.04172	-0.02851	-0.03046
191	9.60	1.90000	0.11774	-0.08045	-0.08596
201	-12.00	2.00000	0.19593	-0.13388	-0.14306

TURBULENT VELOCITY PROFILE

I	THETA	S	UVTI	WTI
1	-12.00	0.0	0.04244	0.05026
11	-9.60	0.10000	0.04244	0.05026
21	-7.20	0.20000	0.04244	0.05026
31	-4.80	0.30000	0.04244	0.05026
41	-2.40	0.40000	0.04244	0.05026
51	0.00	0.50000	0.04244	0.05026
61	2.40	0.60000	0.04244	0.05026
71	4.80	0.70000	0.04244	0.05026
81	7.20	0.80000	0.04244	0.05026
91	9.60	0.90000	0.04244	0.05026
101	-12.00	1.00000	0.04244	0.05026
111	-9.60	1.10000	0.04244	0.05026
121	-7.20	1.20000	0.04244	0.05026
131	-4.80	1.30000	0.04244	0.05026
141	-2.40	1.40000	0.04244	0.05026
151	0.00	1.50000	0.04244	0.05026
161	2.40	1.60000	0.04244	0.05026
171	4.80	1.70000	0.04244	0.05026
181	7.20	1.80000	0.04244	0.05026
191	9.60	1.90000	0.04244	0.05026
201	-12.00	2.00000	0.04244	0.05026

HARMONIC CONTENT OF ROTOR WAKE/VORTEX FLOW

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.029251	-0.000026	-2.11
2	0.013300	-0.000061	-8.96
3	0.005459	-0.000092	-16.70
4	0.002200	-0.000081	-24.59
5	0.000884	-0.000109	-32.50

DIMENSIONAL QUANTITIES

RADIUS = 0.40 FT
WHEEL SPEED = 268.01 FPS
RPM = 6332.51 RPM
BPF = 1583.13 HZ

HARMONIC CONTENT OF ROTOR WAKE/VORTEX FLOW

STREAMLINE NUMBER 1

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.016016	1.085238	-1.36
2	0.034061	-0.590524	5.19
3	0.014778	1.130787	-2.06
4	0.005910	-1.522206	-10.02
5	0.003886	0.428642	-13.66

STREAMLINE NUMBER 2

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.015746	1.087363	-1.77
2	0.033299	-0.563040	4.74

3	0.013498	1.019276	-3.11
4	0.004469	-1.219669	-12.71
5	0.002554	0.257714	-17.56

STREAMLINE NUMBER 3

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.024664	0.172117	1.90
2	0.019835	-0.202510	0.01
3	0.008006	0.176590	-7.87
4	0.003658	-0.002205	-14.67
5	0.001570	-0.050478	-22.02

STREAMLINE NUMBER 4

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.025867	-0.004277	1.53
2	0.013638	0.079655	-4.03
3	0.007123	-0.059623	-9.67
4	0.003347	-0.044773	-16.23
5	0.001757	0.051444	-21.83

STREAMLINE NUMBER 5

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.022583	0.000033	-0.84
2	0.012397	0.025601	-6.05
3	0.006266	-0.002458	-11.97
4	0.003005	-0.016467	-18.36
5	0.001438	0.003199	-24.76

STREAMLINE NUMBER 6

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.019405	-0.000025	-3.51
2	0.010816	-0.000059	-8.59
3	0.005369	-0.000095	-14.67
4	0.002587	-0.000115	-21.02
5	0.001238	-0.000142	-27.42

STREAMLINE NUMBER 7

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.028343	-0.000026	-1.53
2	0.013498	-0.000060	-7.97
3	0.005781	-0.000078	-15.34
4	0.002426	-0.000090	-22.88
5	0.001014	-0.000138	-30.45

STREAMLINE NUMBER 8

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.031149	-0.000026	-1.11
2	0.014063	-0.000059	-8.02
3	0.005734	-0.000085	-15.81
4	0.002298	-0.000060	-23.75
5	0.000918	-0.000129	-31.72

STREAMLINE NUMBER 9

NH	MODULUS	PHASE	20*LOG(MODULUS), DB
1	0.029251	-0.000026	-2.11

2	0.013300	-0.000061	-8.96
3	0.005459	-0.000092	-16.70
4	0.002200	-0.000081	-24.59
5	0.000884	-0.000109	-32.50

TIP-TO-HUB AERODYNAMIC PHASE LAG

STREAMLINE NO.	AERO PHASE LAG
1	0.0
2	-0.077664
3	-0.132939
4	-0.219543
5	-0.402110
6	-0.739243
7	-1.225724
8	-1.430841
9	-1.849295

TURBULENCE SPECTRUM OF ROTOR WAKE/VORTEX FLOW

STREAMLINE NUMBER 1

IFREQ	FREQUENCY	REL DB
1	50.00	-35.41
10	500.00	-25.78
19	950.00	-23.96
28	1400.00	-23.84
37	1850.00	-24.66
46	2300.00	-26.06
55	2750.00	-27.80
64	3200.00	-29.72
73	3650.00	-31.72
82	4100.00	-33.73
91	4550.00	-35.71
100	5000.00	-37.63
109	5450.00	-39.49
118	5900.00	-41.28
127	6350.00	-42.99
136	6800.00	-44.63
145	7250.00	-46.20
154	7700.00	-47.70
163	8150.00	-49.14
172	8600.00	-50.51
181	9050.00	-51.83
190	9500.00	-53.09
199	9950.00	-54.31

STREAMLINE NUMBER 2

IFREQ	FREQUENCY	REL DB
1	50.00	-36.06
10	500.00	-26.32
19	950.00	-24.23
28	1400.00	-23.68
37	1850.00	-23.98
46	2300.00	-24.84
55	2750.00	-26.07
64	3200.00	-27.53
73	3650.00	-29.13
82	4100.00	-30.80

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91	4550.00	-32.49
100	5000.00	-34.17
109	5450.00	-35.83
118	5900.00	-37.44
127	6350.00	-39.01
136	6800.00	-40.53
145	7250.00	-41.99
154	7700.00	-43.41
163	8150.00	-44.77
172	8600.00	-46.08
181	9050.00	-47.34
190	9500.00	-48.55
199	9950.00	-49.72

STREAMLINE NUMBER 3

IFREQ	FREQUENCY	REL DB
1	50.00	-36.53
10	500.00	-26.75
19	950.00	-24.55
28	1400.00	-23.82
37	1850.00	-23.89
46	2300.00	-24.51
55	2750.00	-25.50
64	3200.00	-26.74
73	3650.00	-28.13
82	4100.00	-29.62
91	4550.00	-31.15
100	5000.00	-32.70
109	5450.00	-34.24
118	5900.00	-35.75
127	6350.00	-37.24
136	6800.00	-38.68
145	7250.00	-40.08
154	7700.00	-41.44
163	8150.00	-42.75
172	8600.00	-44.02
181	9050.00	-45.25
190	9500.00	-46.43
199	9950.00	-47.57

STREAMLINE NUMBER 4

IFREQ	FREQUENCY	REL DB
1	50.00	-37.56
10	500.00	-27.72
19	950.00	-25.36
28	1400.00	-24.38
37	1850.00	-24.12
46	2300.00	-24.35
55	2750.00	-24.93
64	3200.00	-25.77
73	3650.00	-26.79
82	4100.00	-27.93
91	4550.00	-29.16
100	5000.00	-30.44
109	5450.00	-31.74
118	5900.00	-33.05
127	6350.00	-34.35
136	6800.00	-35.64
145	7250.00	-36.90
154	7700.00	-38.14

163	8150.00	-39.35
172	8600.00	-40.53
181	9050.00	-41.67
190	9500.00	-42.79
199	9950.00	-43.87

STREAMLINE NUMBER 5

IFREQ	FREQUENCY	REL DB
1	50.00	-38.65
10	500.00	-28.78
19	950.00	-26.35
28	1400.00	-25.24
37	1850.00	-24.82
46	2300.00	-24.85
55	2750.00	-25.22
64	3200.00	-25.84
73	3650.00	-26.64
82	4100.00	-27.58
91	4550.00	-28.62
100	5000.00	-29.72
109	5450.00	-30.87
118	5900.00	-32.04
127	6350.00	-33.22
136	6800.00	-34.40
145	7250.00	-35.57
154	7700.00	-36.72
163	8150.00	-37.85
172	8600.00	-38.97
181	9050.00	-40.05
190	9500.00	-41.12
199	9950.00	-42.16

STREAMLINE NUMBER 6

IFREQ	FREQUENCY	REL DB
1	50.00	-39.40
10	500.00	-29.51
19	950.00	-27.01
28	1400.00	-25.78
37	1850.00	-25.20
46	2300.00	-25.04
55	2750.00	-25.19
64	3200.00	-25.58
73	3650.00	-26.15
82	4100.00	-26.86
91	4550.00	-27.68
100	5000.00	-28.58
109	5450.00	-29.54
118	5900.00	-30.53
127	6350.00	-31.55
136	6800.00	-32.59
145	7250.00	-33.63
154	7700.00	-34.67
163	8150.00	-35.70
172	8600.00	-36.72
181	9050.00	-37.73
190	9500.00	-38.72
199	9950.00	-39.69

STREAMLINE NUMBER 7

IFREQ	FREQUENCY	REL DB
1	50.00	-41.00
10	500.00	-31.12
19	950.00	-28.66
28	1400.00	-27.52
37	1850.00	-27.06
46	2300.00	-27.05
55	2750.00	-27.38
64	3200.00	-27.96
73	3650.00	-28.74
82	4100.00	-29.66
91	4550.00	-30.67
100	5000.00	-31.76
109	5450.00	-32.90
118	5900.00	-34.05
127	6350.00	-35.23
136	6800.00	-36.40
145	7250.00	-37.56
154	7700.00	-38.71
163	8150.00	-39.85
172	8600.00	-40.96
181	9050.00	-42.05
190	9500.00	-43.12
199	9950.00	-44.16

STREAMLINE NUMBER 8

IFREQ	FREQUENCY	REL DB
1	50.00	-41.15
10	500.00	-31.28
19	950.00	-28.84
28	1400.00	-27.73
37	1850.00	-27.32
46	2300.00	-27.37
55	2750.00	-27.77
64	3200.00	-28.43
73	3650.00	-29.27
82	4100.00	-30.26
91	4550.00	-31.34
100	5000.00	-32.48
109	5450.00	-33.67
118	5900.00	-34.88
127	6350.00	-36.10
136	6800.00	-37.31
145	7250.00	-38.51
154	7700.00	-39.69
163	8150.00	-40.85
172	8600.00	-41.99
181	9050.00	-43.11
190	9500.00	-44.20
199	9950.00	-45.26

STREAMLINE NUMBER 9

IFREQ	FREQUENCY	REL DB
1	50.00	-41.57
10	500.00	-31.69
19	950.00	-29.21
28	1400.00	-28.03
37	1850.00	-27.52
46	2300.00	-27.45
55	2750.00	-27.72

64	3200.00	-28.23
73	3650.00	-28.94
82	4100.00	-29.79
91	4550.00	-30.75
100	5000.00	-31.78
109	5450.00	-32.87
118	5900.00	-33.98
127	6350.00	-35.11
136	6800.00	-36.25
145	7250.00	-37.38
154	7700.00	-38.50
163	8150.00	-39.61
172	8600.00	-40.70
181	9050.00	-41.77
190	9500.00	-42.82
199	9950.00	-43.85

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6.0 INPUT FILES FOR ROTOR-55, JT15D FAN ROTOR, AND ROTOR-67

This section contains the input files for Rotor-55, JT15D Fan Rotor, and Rotor-67 that were employed in the data-theory comparisons described in Section 5.1 of Reference 1.

Input File for Rotor-55 at 80% Design RPM

```
&INPUT
KASE=3,
VREF=10.0,
IWAKE=1,ITPVTX=1,IHBVTX=0,
ISHAPE=1,
SBN(1)=0.42,
VVTR=0.0,
N=101,
NSTR=9,
SR=.970,.943,.916,.835,.728,.620,.539,.512,.485,
SXOCH=.435,.439,.440,.475,.540,.622,.700,.728,.758,
SSIGR=.896,.905,.919,.948,.998,1.063,1.130,1.157,1.186,
RSTAGR=38.96,37.05,35.44,30.66,24.22,17.48,11.74,9.73,7.69,
SSIGS=.733,.753,.773,.841,.951,1.091,1.228,1.282,1.341,
NBLADE=15,
NVANE=25,
ICD=2,
SWR=.134,.103,.099,.047,.031,.020,.086,.129,.108,
SSTHET=.486,.481,.496,.562,.688,.830,.967,1.009,1.098,
SSEMA=.291,.317,.328,.334,.323,.314,.285,.275,.277,
SSEMT=.478,.464,.452,.413,.360,.308,.265,.253,.240,
WTIV=0.0,
BETAW=0.0,
TAU=0.009,
RAWDS=2.462,
FOPT=1.0,
NHT=5,
WOPT=0.0,
HTR=0.46,
ITURB=1,
RWALL=0.8333,
AO=1116.7,
SSTAGR=12.15,12.36,12.57,13.28,14.07,15.00,15.67,15.88,16.09,
NFREQ=200,
DELFRQ=50.0,
ISTATR=1,
&END
&INPUT
SXOCH=1.008,1.023,1.032,1.106,1.230,1.384,1.523,1.573,1.625,
&END
&INPUT
SXOCH=1.457,1.479,1.495,1.599,1.770,1.980,2.167,2.234,2.304,
&END
```

Input File for Rotor-55 at 96% Design RPM

```
&INPUT
KASE=3,
IWAKE=1,ITPVTX=1,IHBVTX=0,
ISHAPE=1,
SBN(1)=0.42,
VVTR=0.0,
N=101,
NSTR=9,
SR=.970,.943,.916,.835,.728,.620,.539,.512,.485,
SXOCH=.435,.439,.440,.475,.540,.622,.700,.728,.758,
SSIGR=.896,.905,.919,.948,.998,1.063,1.130,1.157,1.186,
SSIGS=.733,.753,.773,.841,.951,1.091,1.228,1.282,1.341,
NBLADE=15,
NVANE=25,
ICD=2,
SWR=.087,.064,.057,.037,.033,.024,.078,.134,.123,
SSTHET=.424,.430,.452,.537,.674,.832,.983,1.028,1.105,
SSEMA=.379,.410,.419,.415,.403,.389,.362,.339,.340,
SSEMT=.544,.530,.515,.469,.408,.347,.302,.287,.271,
WTIV=0.0,
BETAW=0.0,
TAU=0.009,
RAWDS=2.462,
FOPT=1.0,
NHT=5,
WOPT=0.0,
HTR=0.46,
ITURB=1,
RWALL=0.8333,AC=1116.7,
SSTAGR=12.15,12.36,12.57,13.28,14.07,15.00,15.67,15.88,16.09,
NFREQ=200,
DELFRQ=50.0,
ISTATR=1,
&END
&INPUT
SXOCH=1.008,1.023,1.032,1.106,1.230,1.384,1.523,1.573,1.625,
&END
&INPUT
SXOCH=1.457,1.479,1.495,1.599,1.770,1.980,2.167,2.234,2.304,
&END
```

Input File for Rotor-55 at 115% Design RPM

```
&INPUT
KASE=3,
IWAKE=1,ITPVTX=0,IHBVTX=0,
SBN(1)=0.42,
ISHAPE=1,
VVTR=0.0,
N=101,
NSTR=9,
SR=.970,.943,.916,.835,.728,.620,.539,.512,.485,
SXOCH=.435,.439,.440,.475,.540,.622,.700,.728,.758,
SSIGR=.896,.905,.919,.948,.998,1.063,1.130,1.157,1.186,
SSIGS=.733,.753,.773,.841,.951,1.091,1.228,1.282,1.341,
NBLADE=15,
NVANE=25,
ICD=2,
SWR=.125,.069,.053,.042,.032,.019,.074,.130,.118,
SSTHET=.444,.445,.463,.557,.689,.847,.998,1.033,1.090,
SSEMA=.458,.499,.510,.512,.488,.489,.452,.426,.428,
SSEMT=.674,.655,.636,.579,.504,.430,.374,.355,.336,
WTIV=0.0,
BETAW=0.0,
TAU=0.009,
RAWDS=2.462,
FOPT=1.0,
NHT=5,
WOPT=0.0,
HTR=0.46,
ITURB=1,
RWALL=0.8333,AO=1116.7,
SSTAGR=12.15,12.36,12.57,13.28,14.07,15.00,15.67,15.88,16.09,
NFREQ=200,
DELFRQ=50.0,
ISTATR=1,
&END
&INPUT
SXOCH=1.008,1.023,1.032,1.106,1.230,1.384,1.523,1.573,1.625,
&END
&INPUT
SXOCH=1.457,1.479,1.495,1.599,1.770,1.980,2.167,2.234,2.304,
&END
```

Input File for JT15D Fan Rotor

```
&INPUT
KASE=4,
VREF=10.0,
IWAKE=1,ITPVTX=1,IHBVTX=0,
ISHAPE=1,
SBN(1)=0.45,
VVTR=0.0,
N=101,
NSTR=4,
SR=0.9381,0.8649,0.7849,0.6750,
SXOCH=0.7096,0.7262,0.7491,0.7690,
SSIGR=1.34,1.375,1.42,1.53,
SSIGS=1.63,1.75,1.91,2.25,
NBLADE=28,
NVANE=66,
ICD=3,
SSTHET=0.3115,0.3214,0.3345,0.3660,
SSEMA=4*0.1698,
SSEMT=0.5417,0.4994,0.4533,0.3898,
WTIV=0.0,
BETAW=0.0,
TAU=0.0072,
RAWDS=4.4659,
FOPT=1.0,
NHT=5,
WOPT=0.0,
HTR=0.4342,
ITURB=0,
RWALL=0.9117,
AO=1116.7,
SSTAGR=4*10.0,
NFREQ=200,
DELFRQ=50.0,
ISTATR=0,
&END
&INPUT
SSTHETA=0.3128,0.3230,0.3365,0.3688,
SSEMA=4*0.2280,
SSEMT=0.6822,0.6289,0.5708,0.4909,
&END
&INPUT
SSTHETA=0.3134,0.3237,0.3374,0.3701,
SSEMA=4*0.2644,
SSEMT=0.7705,0.7103,0.6447,0.5544,
&END
&INPUT
SSTHETA=0.3138,0.3242,0.3380,0.3709,
SSEMA=4*0.2910,
SSEMT=0.8347,0.7695,0.6984,0.6006,
&END
```

Input File for Rotor-67, Stage I, 10% Span from Tip

```
&INPUT
KASE=7,
IWAKE=1,ITPVTX=1,IHBVTX=0,
SBN(1)=0.42,
VVTR=0.0,
N=101,
NSTR=1,
SR=0.946,
SXOCH=0.247,
SSIGR=1.364,
SSIGS=1.334,
NBLADE=22,
NVANE=34,
ICD=2,
SWR=0.066,
SSTHET=0.379,
SSEMA=0.454,
SSEMT=1.162,
WTIV=0.0,
BETAW=0.0,
TAU=0.004,
RAWDS=3.455,
FOPT=1.0,
NHT=5,
WOPT=0.0,
HTR=0.477,
ITURB=1,
RWALL=0.8141,
AO=1116.7,
SSTAGR=11.23,
NFREQ=200,
DELFRQ=50.0,
ISTATR=0,
&END
&INPUT
SXOCH=0.370,
&END
&INPUT
SXOCH=0.443,
&END
&INPUT
SXOCH=0.493,
&END
&INPUT
SXOCH=0.616,
&END
&INPUT
SXOCH=0.677,
&END
&INPUT
SXOCH=1.0,
&END
```

Input File for Rotor-67, Stage I, 50% Span from Tip

```
 &INPUT
 KASE=9,
 IWAKE=1,ITPVTX=1,IHBVTX=0,
 SBN(1)=0.42,
 VVTR=0.0,
 N=101,
 NSTR=1,
 SR=0.738,
 SXOCH=0.0,
 SSIGR=1.772,
 SSIGS=1.670,
 NBLADE=22,
 NVANE=34,
 ICD=2,
 SWR=0.024,
 SSTHET=0.509,
 SSEMA=0.497,
 SSEMT=0.906,
 WTIV=0.0,
 BETAW=0.0,
 TAU=0.004,
 RAWDS=3.455,
 FOPT=1.0,
 NHT=5,
 WOPT=0.0,
 HTR=0.477,
 ITURB=1,
 RWALL=0.8141,
 AO=1116.7,
 SSTAGR=14.27,
 NFREQ=200,
 DELFRQ=50.0,
 ISTATR=0,
 &END
 &INPUT
 SXOCH=0.106,
 &END
 &INPUT
 SXOCH=0.211,
 &END
 &INPUT
 SXOCH=0.315,
 &END
 &INPUT
 SXOCH=0.345,
 &END
 &INPUT
 SXOCH=0.420,
 &END
 &INPUT
 SXOCH=0.525,
 &END
 &INPUT
 SXOCH=0.585,
 &END
 &INPUT
 SXOCH=1.0,
 &END
```

7.0 REFERENCES

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